Implementation of local holistic mobile climate services in forestry: Case study in Kenya

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Abstract

Mobile phone implementation diffusion dynamics for various applications is different in *developed* and *developing* countries. The emphasis is on sustainable development with its four pillars: environmental, economic, social and ethical. Technology and circumstances are better known in developed countries than in developing countries. Essential differences exist.

The practical example is that of creating holistic grass-root mobile climate services (HGMCS) environment for forestry according to the requirements in Kenya. Especially messaging and data management services are important. This thesis studies and finally makes a proposition about a mobile phone technology and application network system. The proposed system allows and encourages sustainable development as well as takes into account the level of technology possible to use in the particular region of Kenya.

Based on the analysis, proposition on a smart mobile phone network application in Kenya is made. The local University of Eldoret in Kenya needs application to develop their forestry curriculum. Application is important also for local farmers.

Data is collected from questionnaires and document sources. Also local people and visitors are interviewed.

Keywords: smart phones, mobile application, diffusion dynamic, developing country, developed country, sustainable development

CR Categories (ACM Computing Classification System, 1998 version):
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Tiivistelmä

Mobiilisovellusten leviämisen dynamiikka on erilainen kehittyneissä ja kehittyvissä maissa. Tässä asiayhteydessä näkökulmana on kestävä kehitys. Tutkimus on pääasiassa keskittynyt siihen. Neljä kestävän kehityksen päätekijää ovat ympäristö, talous ja sosiaalinen ja eettinen näkökulma. Teknologia ja olosuhteet ovat tunnetumpia kehittyneissä maissa kuin kehittyvissä maissa. Oleellisia eroja on olemassa.

Käytännön esimerkki, erikoisongelma tulee ilmastopalvelun asetelmista ja vaatimuksista Keniassa. Erityisesti viestinnän ja tiedonhallinnan palvelut ovat tärkeitä. Tutkielma tutkii ja lopuksi tekee ehdotukset älypuhelimiin ja sovellukseen perustuvasta verkostosta. Se rakennetaan osaltaan kestävää kehitystä tukevaksi kehitysmaakontekstissa.

Analyysin perusteella tehdään ehdotus älypuhelinverkkosovelluksesta Keniassa Paikallinen Eldoretin yliopisto Keniassa tarvitsee sovellusta kehittäessään metsätieteiden opetusohjelmaansa. Sovellus on tärkeä myös paikallisille maanviljelijöille.

Tieto on kerätty kyselyillä ja dokumenttilähteistä. Myös paikallisia ihmisiä ja vierailijoita on haastateltu.

Avainsanat: älypuhelin, mobiilisovellus, kehittyvä maa, kehittynyt maa, leviämisen dynamiikka, kestävä kehitys

ACM-luokat (1998 versio):
D.1.1 Sovellus(toiminnallinen)Ohjelmointi

Foreword

This research was done at the University of Eastern Finland/School of Computing department between June 2013 and November 2014. It has been quite a long process to understand what is happening in Kenya.

The purpose of this Master thesis is to *compare mobile implementations* worldwide through *diffusion dynamics* as illustrated by the implementation of local *holistic mobile climate services* in Kenya. The mobile implementations of a *developing country*, in this case Kenya, are compared with that of a *developed country*, namely Finland. The aim is to foster sustainable development in developing country contexts and to investigate what is the best way to build a mobile implementation, keeping global thinking in mind. The investigation tries to establish possible differences between areas and then ascertain their potential effects on a mobile implementation and its development process.

Collecting the data from Kenya has been difficult. I forwarded the questionnaire three times along with people who went there. I only received one answer. I was told that it is hard to collect information. It looks as if the local people do not want to give it because it has business implications to them. It also looks like a developing country strategy to procure financial aid. People may think there that better not to tell anything about business things as the application development is mostly pursued by private sector. Therefore this research is predominantly made through public information sources. However, I believe that it gives a correct idea of the situation of mobile implementation development situation in Kenya. Without having actually visited Eldoret, Kenya this information is difficult to confirm. However, persons referred to in this study confirm this information.

As noted in the conclusion, this study raises more questions on the local social-economic situation in Kenya. In this study mobile implementation development in Kenya has been compared with the situation in Finland. In doing the comparison it looks as if, in many instances, there are things that are the similar but also that many things look different. Use of mobile data development processes is partly different in developing countries and still years behind that of the developed countries.

I want to thank my wife who helped me to free up time to do this study. I want to thank professor Erkki Sutinen and Jaakko Helminen, who supplied me with information about the situation in Kenya. I am also grateful for the questionnaire responses, which I have received from Santtu Åkerman, Tapani Toivanen, Almany Touray and Mark Irura.

Joensuu,

December 2014

Kari Eronen

List of abbreviations

3G,4G	Third and fourth generation of mobile networks (data services)
ACM	Association for Computing Machinery
ADSL	Asymmetric Digital Subscriber Line
APP	Mobile application
ARPU	Average revenue per user
CDMA	Code division multiple access
CDR	Call Detail Record
DFID	Department for International Development
DIFFUSION DYNAMICS	Worldwide existence of thing (abstract / physical)
GSM	Global System for Mobile Communications, 2G –network (2nd generation)
HGG	Hybrid application with separated Gmail and mobile google drive
HGMCS	Holistic Grass Root Mobile Climate Services
HYBRID	APP run inside a native container by web-to-native abstraction layer
ICT	Information and communications technology
IPCC	Intergovernmental Panel on Climate Change
KFRI	Kerala Forest Research Institute
KMD	Kenya Meteorological Department
LMS	Learning Management System
LOW-END PHONE	A feature phone. Mobile phones which are limited in capabilities
M-PESA	Mobile-phone based money transfer service by Safaricom
MGD	Mobile Google Drive, cloud service
MOBILE APPLICATION	Application software designed to run on smartphones, tablet computers and other mobile devices.
MTSO	Mobile Telephone Switching Office, mobile equivalent to PSTN
NATIVE APP	Smart phone application that is coded in a specific programming language. They also have access to a phone's various devices.
NGG	Native application with separated Gmail and mobile Google Drive
P2P	type of decentralized and distributed network architecture in which individual nodes in the network (called *"peers"*) act as both suppliers and consumers of resources
PENETRATION	The degree to which a product or service is known and/or used

PSTN	Public Switched Telephone Network
SERVER CLIENT	Client nodes request access to resources provided by central servers
SMART PHONE	Mobile phone with more advanced computing capability and connectivity
TDMA	Time division multiple access
UEF	University of Eastern Finland
UMTS	Universal Mobile Telecommunications System
UOE	University of Eldoret
WEB APP	Any application software that runs in a web browser or is created in a browser-supported programming language (such as the combination of JavaScript, HTML and CSS)
WGG	Web Application with separated Gmail and mobile google drive
WI-FI	Local area wireless technology

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1 INTRODUCTION

1.1 Purpose of Master´s thesis

The purpose of this Master thesis is to *compare mobile implementations* worldwide through *diffusion dynamics* as illustrated by the implementation of local *holistic mobile climate services* in Kenya. The mobile implementations of a *developing country*, in this case Kenya, are compared with that of a *developed country*, namely Finland. The aim is to foster sustainable development in developing country contexts and to investigate what is the best way to build a mobile implementation, keeping global thinking in mind. The investigation tries to establish possible differences between areas and then ascertain their potential effects on a mobile implementation and its development process.

1.2 Factors affecting the development

Developmental aid to developing countries is a well-known global phenomenon. ICT for development and ICT for education are also two familiar concepts. Developmental aid can be introduced in many different ways. The most traditional way is offering services, as done by many aid organizations, to developing countries. It is also possible to give economic support directly to the end users. Some people think that this is the preferred option as end users *know best* what they need in order to improve their standard of living and the support, often in the form of money, goes to the right people.

The purpose of this Master thesis is to compare the *diffusion dynamics of mobile implementations* in a developed country to that of a developing country. It means the common use of mobile implementations on the general level. With this purpose and context in mind, the study tries to find a solution to a specific problem: What is the best sustainable way to build a smart mobile phone network implementation to meet the needs of the Department of Forest Science at the University of Eldoret. The nature of this implementation is also important to farmers who need the same

information. Generally thinking, farmers do not have smart mobile phones in use. They use mostly low-end mobile phones, if any at all.

If one assumes that this is a normal software development project, the local circumstances in Kenya will not be much of a concern. According to the requirement specifications of the project this thesis focuses mainly on the beginning phase. The main purpose is to determine its sustainability and sustainable development. Then subsequently produce the best architectural solution for a recommended system.

This Master thesis research is governed by the requirements of the Holistic Grass-Root Mobile Climate Services (HGMCS) project in Kenya, especially with reference to messaging services and data management. The unique challenge is to study and then to design a proposition regarding a smart phone based implementation of a mobility technology messaging system. This implementation is to be built technically in a sustainable way, which is suited to a developing country context.

1.3 Sustainable development

When one attempts an evaluation process of evaluation from the perspective of sustainable development, it can be done in the following way. Meaning is to build mobile phone application (HGMCS related) for students at the University of Eldoret in the first phase. Finally later possible farmers use it also but after the link between University and local people has worked correctly as in the developed countries.

One firstly needs to consider the commercial and legal aspects and therefore it is important to build a business case scenario. One needs to ask *who* would be interested in the offered solution? *How much* would they be willing to pay (in both attention and money) of the development and production process? In the particular developing country are there *legal or other constraints* which need to be taken under into account? It is not realistic to design solutions in Finland and expect that these solutions would then automatically be worked in Africa. As proposed by this thesis, it is preferable that as much as possible must be designed by the local people as they are finally in the best position to judge what they really need.

After it has been clearly ascertained that the offered solution is welcomed, the second step is to decide how to implement the solution technically. This means that one has to consider carefully which technical solution would best suit the developing country context, while ensuring that it is not too heavy and cumbersome or too expensive to be realized in practice.

Maybe the best way to implement the business case approach might be just to list the available options and then ask the local people which option they prefer. At first one might show them a prototype (if one is available) and if they are interested in it one might continue along that course. The building of a simple prototype is considered a good approach to awaken the interest of people. It is further important to note that 90 percent of all expenses are already tied up in the design phase of the project. This is not any different from other projects and proto-type related ventures in the world at large and only serves once again to highlight the importance of the design phase.

It is also important to take a practical stand regarding this type of a venture as one needs to know, after the developmental phase has been completed, who will pay for and maintain the service to ensure that the applications continue to be used. One also needs to investigate the ways in which the application will remain relevant to users as their own needs evolve and change. It is of no use to build applications which are never used.

One way to inform the essential sustainability of applications is to employ the indicators as noted in a study published by the University of Eastern Finland [27]. The four pillars of sustainable development relate to *environmental, economic, social* and *ethical* factors.

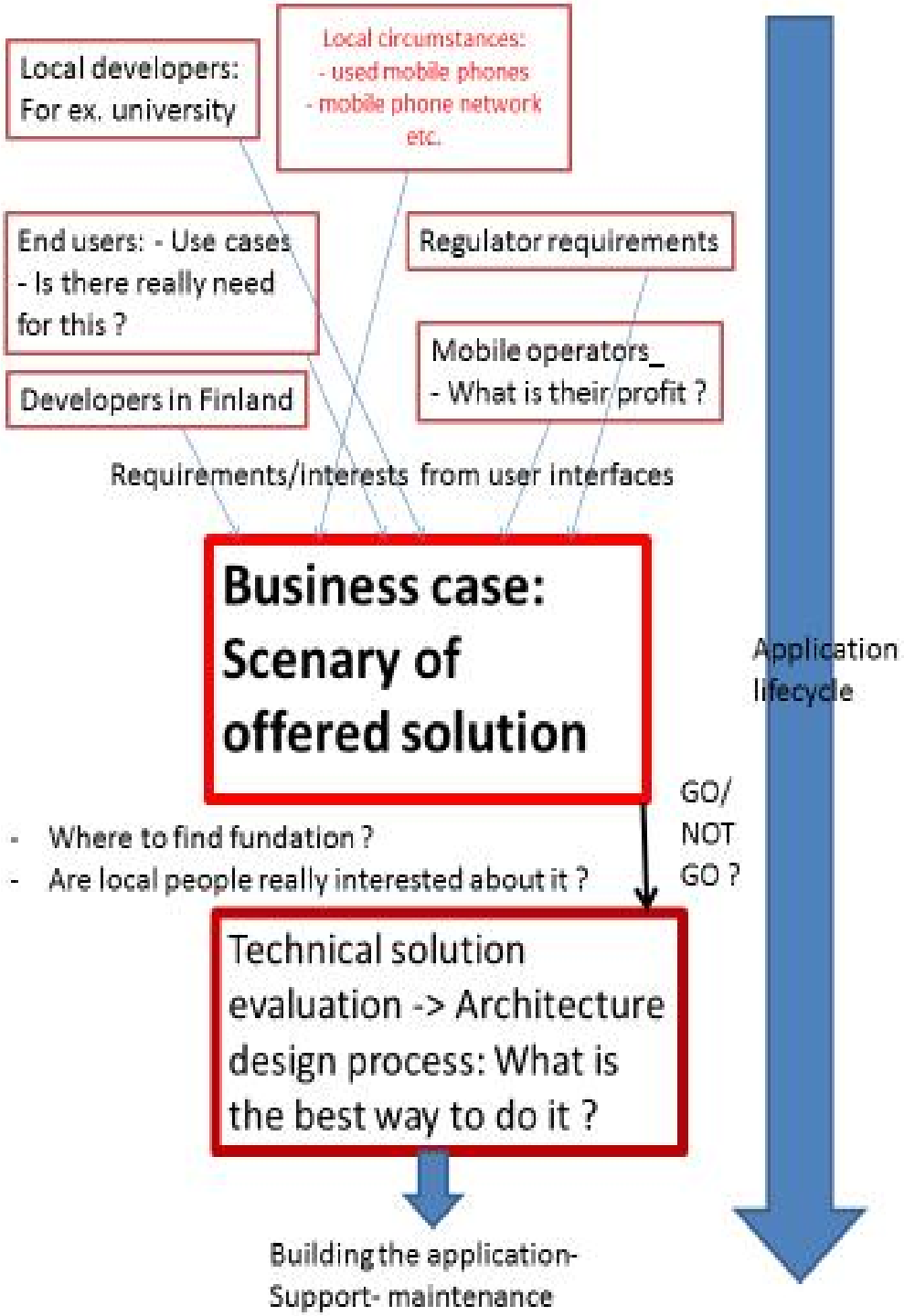

Figure 1: Business case scenery

1.4 Increasing data amounts and transfers

The increase in data amounts and transfers is an aspect, which relates directly to the development of mobile data services. As we can deduce from the news and statistics the number of mobile data applications and mobile technology inventions is increasing rapidly, especially in developing countries. Consequently the amount of mobile data transfers is also accelerating heavily in developing countries [9, 10, 13 and 16]. This creates pressure on local mobile operators to develop their network services.

The availability of internet links also tells us more about the data amount and transfer situation in Africa [15, 24 and 26]. More detailed information about Kenya is available in internet [3 and 18].

There are several differences in the use of smart phones in developed and developing countries. In the next two chapters these differences are explored further.

1.5 Features unique to *developed* countries

Mobile device availability in developed countries is highly covering [13] and the number of mobile phones can even exceed the number of users. Data is frequently used for collecting information via mobile applications. More than 90% of people use the three most common operating systems (Android, iOS, Windows). A big number of applications, web and special mobile java based (native, hybrid), are available for use. These applications are well known and easily navigated. They become rapidly more and more prevalent in the business world. In some cases they replace computers. *Saturation levels are high* and email is commonly used. Generally speaking with some exceptions the development is years ahead of the developing countries.

Email is used to transfer files but it is PC based because of the common use of the PSTN network. Cloud-based services are popular as well e.g. Dropbox, etc. Generally speaking in developed countries it would be much easier to build a

continuum of a PC internet network as mobile smart phone services integrated to PC services. Because one can find an ADSL network almost everywhere, smart phones can be connected to them easily via local area wireless technology. Of course the situation is different if one enters a remote area, for example a forest, where there is only a 3G network available. Only then the situation is like the one in a developing country.

As shown in Figures 2 and 3, the essential difference between *developed* and *developing* countries is the fixed network. The ADSL broadband internet connections are much more common in developed countries because public switched telephone networks have already existed there for a long time.

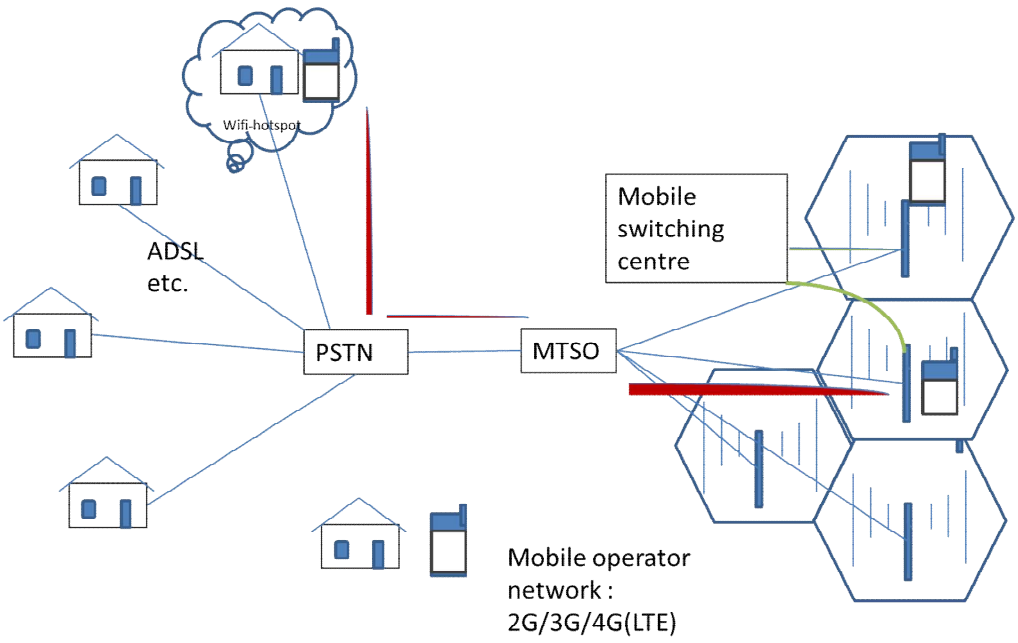

Figure 2: Telecommunication network in developed countries

1.6 Features unique to *developing* countries

In these countries people frequently use prepaid mobile phone subscriptions in which the speech and data services are separated. Phone bills can be high, especially when compared with other living expenses [Appendix 1].

A fixed network is often missing and this is especially true in rural areas. The first experiences of people with a phone would most probably be a mobile one. The use of data is not common and data transfer is expensive. Even a 3G network is not readily available everywhere in rural areas. Mostly people use mobile phones to speak with each other. Discussions can be lengthy and start often by asking how the other person is feeling. A remarkable amount of income is spent on mobile phones and mobile phone communication. There is also a wider variety of phone models in use than is the case in developed countries.

The use of Android is popular because Apple and Nokia (which uses Windows 8) are expensive devices. Android devices are more affordable.

Email is used for data transfer, partly in the same way as it is used in the developed countries, by PC web browser with a data connection to the internet. In some cases it can be even be used via mobile phone data connection to the internet. However, its use is much more limited compared with developed countries. Not everybody has a PC data connection, especially not in rural areas, where only restricted mobile applications are available. They cater to and are dictated by local needs.

The availability and spread of mobile devices is constantly rising at a significant rate and this is true of data transfer as well. For this reason mobile operators develop networks because it is a profitable business decision. In some African countries business conducted via mobile phones affected even positively the gross domestic product. This trend has opened up new business models in which people can network efficiently and explore new business opportunities. Because fixed networks have not been available in rural areas a money transfer service, M-PESA, has been established in Kenya. It became popular because it addressed the needs of those who do not have

formal access to banking facilities. M-PESA is, however, not a banking service, but a money transfer service which has evolved also into a popular mode of payment. The analogy therefore meant that mobile money is plastic money.

The sense of time is different in Africa and Africans are not generally used to or comfortable with the rhythm inherent in developed countries. In most of the developing countries, economy is currently developing fast.

A list of challenges faced by IT projects in developing countries is available [28, 29 and 31]. It is safe to state that most of them are different than the challenges posed to developed countries. It can be assumed that IT projects would, in essence, differ in these two contexts. The governance of IT projects, especially in the public service realm, is of great concern.

Figure 3 shows that only mobile services are available to people in rural communities and this has affected the development of mobile implementations in developing countries in different ways.

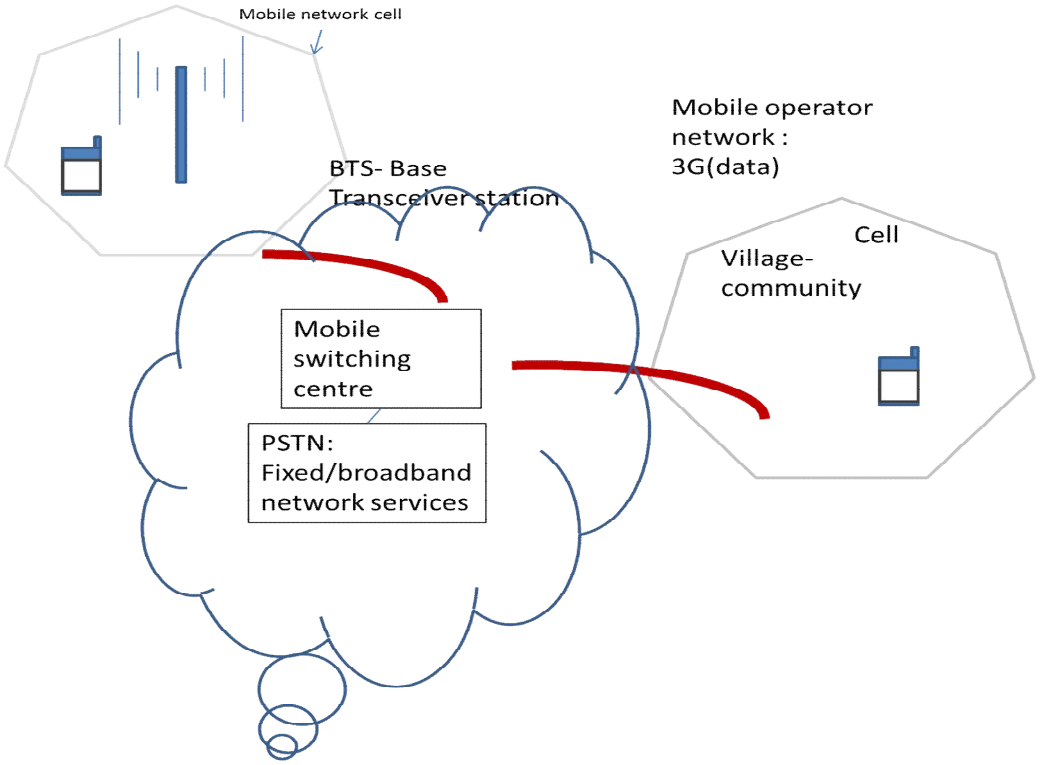

Figure 3: Telecommunications network in the rural areas of developing countries

1.7 Differences between *developed* and *developing* countries

Table 1 explains the most essential differences between developed and developing countries. The point of view there is mostly the technical development of the mobile telecommunication network domain.

Table 1: Comparison between developed and developing countries

VALUE:	**DEVELOPED COUNTRIES**	**DEVELOPING COUNTRIES**
Penetration	High	low, rising fast
use of data	High	low, rising fast
data transfer prize	low	Higher
available mobile phones	many, 90 % of users stick to the three most common models	many, Android phones (low-end) are mostly in use
available applications	many	few, relevance rising
email in use	yes, many choices to use it	yes, use of it not so common
pc with internet connection	yes, many choices to use it	use of it not so common
fixed network	yes, almost everywhere	not common in the countryside
mobile operators network development status	3g everywhere	3g almost everywhere
mobile operators network development speed	Not fast, markets are saturated	fast, development depends on the needs of local business
sense of time	Faster	Slow, development usually takes place slowly

1.8 ICT for development and education in Africa

The use of ICT for development, especially if it is connected to mobile applications, is a multi-dimensional and worldwide/global phenomenon. There are many features which have to be taken into account like technology, business and politics. These dimensions stem from different mobile phone implementation tracks [2, 6 and 22].

As stated earlier, these may even vary within one developed country (as is the case in the USA), without mentioning the vast differences between Africa and Europe. Some features come from developed countries and some evolve in developing countries. A good example of this occurrence is M-PESA which was funded by the DFID [4 and 23].

1.9 Objectives and structure of the study

The purpose of this Master thesis is to *compare mobile implementations* worldwide through *diffusion dynamic* and use it as information source for objectives. The objectives of this study are: *firstly* to implement the HCMGS application to improve the knowledge of mobile implementations in Kenya and to compare them with the situation in Finland as well as between each other and, *secondly* to develop this part of the curriculum of the Department of Forest Science at the University of Eldoret and then to transfer this application to Kenyan farmers as a modified version.

The structure of this Master thesis is as follows: the first chapter introduces the purpose of the thesis; the second chapter relates the governing theory behind this Master thesis; the third chapter deals with the methods and materials used in this study; the fourth chapter analyzes possible solutions; the fifth chapter aims to stimulate discussions about the analysis and finally the sixth chapter presents conclusions and makes recommendations as to the possible future research.

2 THEORY OF THE STUDY

2.1 Theoretical background

The purpose of this study is to examine what is needed, what can be done and how the model will work in practice. The governing point of view is the facilitation of sustainable development based on a mobile network implementation in the context of a developing country, Kenya. The ICT development, which is necessary in the establishment of the required mobile application, must also be understood. One of the challenges is to market this point of view to mobile operators, developers and smart mobile phone companies.

Because telecommunications also form an essential part of global weather services, this network forms a natural part of the whole project. Telecommunication networks must be designed and built so that they allow multiple level communications. It is also very important to build the solution so that local people are highly committed to it. This IT project must be designed within the local context so that all the relevant and important factors are understood and incorporated. In this way the knowledge becomes available to all local people who need to access it. There are several challenges like the training of people to use the applications. One cannot take it as given that even local people have necessary funds to buy smart phones.

The HGMCS project has two goals, the first being to design a course for forest science students at the University of Eldoret.

This study is focused on the use of methods, on how to find best possible smart mobile phone network for this case. The area where this study was carried out was in the northwestern Kenya. The University of Eldoret and its Department of Forest Science want to develop a MSc level course on local holistic climate services of forestry and test its functionality by an application at their forest experimental area in Baringo-Marigat. One substantial part for this course is the smart mobile phone network.

The course is demonstrated in the Baringo-Marigat area by a field experiment using a smart mobile phone network prototype model. The university test station is situated in this area. There are four communities which test this solution during its developmental phase. The project produces the prototype model course, including the local smart mobile phone network.

Second goal is to carry out project results from the university to local people by HGMCS mobile application. It is important to notice how local people access the information. Do they have smart phones and if so, do they need training to use these phones? These challenges must prevail by the end of the project. Even if Eldoret is considered a wealthy large scale farming town, in essence it is rural and users will need proper recognition and sensitization.

Presumable, not all local people have smart phones. They may have low-end mobile phones, which are meant mostly for talking. Or some people may not have mobile phone at all. This may be the problem, but solution to access information in villages is available by common way. In every village will be at least one smart phone, where this information is available to everybody. As a result of limited resources, there will initially be only one person in every community to implement the solution first. This person is responsible to look after the smart mobile phone, which uses this application. In the future there will most likely be a strong spread of smart mobiles phones in the Kenyan countryside, as well as the in rural areas of other developing countries, and this is why the smart mobile was chosen as our supported hardware.

This study builds upon previous history of related research. The case study about the development of mobile implementations in Kenya is created. Firstly there is a focus on the development of mobile implementations in a developed country. Secondly the focus is on the development of mobile implementations in a developing country (the current situation in Africa). Finally the analysis focuses on one developing country, Kenya. The concrete example under consideration is a smart mobile phone network implementation in the project HGMCS. This motivates one to think in terms of

sustainable development: what would be the best way to design a solution for this project?

There are already smart mobile implementations in Kenya, which work well to help local farmers. One example of them is Mfarm [20]. It gives up-to-date market information, link farmers to buyers through their marketplace and current agri-trends. It is very useful for farmers.

HGMCS-application is also useful for farmers. It gives them up-to-date information about long term weather conditions and helps them to understand better, what is the best way for farming. The relevance of this kind of applications is rising [8]. Especially in developing countries, climate changes might affect even to the ground. Average temperature in the world is rising as well as the precipitation can vary and change considerably. These variations and changes can cause many problems.

2.2 ICT for education

> Willis stated that: "Educational Technology is a professional field where knowledge and expertise from many disciplines are utilized to design, produce, and use learning materials, applications [tools/environments/artifacts] and procedures" (Willis, 2008).

This Master thesis focuses on the ICT in the context of development. The point of view is a mobile technology application development in Kenya, eastern Africa. According to the assigned task, the purpose is to have an actual recommendation of a data management application based on smart mobile phone technology. This application is, at first, intended for the use as a teaching concept by students of the Department of Forest Sciences at the University of Eldoret.

This subject is currently actual in Africa. According to the latest news mobile technology development has even an effect on the gross domestic product [26].

Earlier research on mobile technology has been done on the basic level. For example, studies regarding the use of the ICT in education in Africa [21] generally reveal more

about the general situation. However, the studies have not been focused on any specific application like our study aims to do.

There is an abundance of relevant research history available and in addition, the technical development of mobile networks has promoted the situation as well. People buy affordable mobile phones, but not necessarily the cheapest ones. In the future, as a result of the global economic management, it might not be possible to divide the world clearly into developing and developed countries. In addition mobile phones develop very quickly and function, for all extensive purposes, as computers, despite of some restrictions inherent in their size. As mentioned before, much research has been devoted to the use of ICT for education.

In addition research from the social media revolution [17] has informed us about its implications for the development of democracy in sub-Saharan Africa.

This research field, the use of mobile technology in the field of ICT for education in the context of a developing country, presents certain challenges. The purpose of this study is to formulate and present a business case to motivate and make certain recommendations regarding a *mobile network application in Kenya*. The main feature of the application is the data management via a mobile gateway, which makes it even more challenging.

The transfer of mobile data is increasing rapidly in Kenya and this offers many opportunities. It has even had effects on the economy [26].

2.3 The theoretical starting point

As already stated, statistics from the ICT for development in Africa tell us that research has been done on a general level. There is no specific research reported from a large mobile technology network, within the wider ICT area of research for education. This makes the study unique. No experts are willing to give interviews and there is also a lack of publications.

In Kenyan rural areas, there is no fixed network available. Therefore the initial startup (which is necessary to develop an application) will differ from the same process in developed countries. That is partly the reason why the mobile technology in Kenya has developed in a different way. The money transfer M-PESA [23] application, which allows people to transfer money via mobile application, is a good example of this. M-PESA was originally a money transfer service that evolved into a banking application.

The design of any of the tasks to determine the best possible way to proceed with the creation of this smart mobile phone network is also interesting because its intended functionality is wide. In practice this kind of functionality is easier to construct in the area of an existing fixed network. In developed countries, one possible way to do this would be to facilitate an extension to a fixed internet network. For example, Android app + Wi-Fi / 3G connection to be linked to the internet using a cloud based application such as Google drive.

In Kenya this is not possible because there is no fixed network and the whole solution must be developed around a smart phone solution with a total mobile network. This sets certain challenges, regarding especially data transfer and data administration. How would one do this in a cost efficiency sensible way? When the circumstances mentioned above prevail, one must seek other ways to build up the application. These choices are discussed further in chapters three and four.

This study pays attention to the following themes for the development of the needed smart mobile network: *What is needed? What can be done? How does the network work in action?* and lastly How to *enhance the technical sustainable development in a developing country*. Also the marketing of this idea to operators and mobile phone producers forms an essential part of this process. This thesis compares also the solution(s) to the challenges faced in a developing country with those found to work well in developed countries. Finally, recommendations on best choices are given in the conclusions.

2.4 Meaningful educational roles for the ICT in developing countries

ICT can reduce the differences in values of life in developed and developing countries.

This is possible by focusing resources towards good Learning Management Systems (LMS) [1, 21 and 32]. Teachers must be well qualified so that the LMS means to them much more than just the internet. The problem is that in most parts of Africa [13], especially in rural areas, one cannot rely on a good internet connection. Local teachers need to learn more about the ICT in order to use it to facilitate learning. This is still the problem in the ICT use at schools.

By using the ICT it is possible for students to attain a high standard education; this is true in both developing and developed countries. By introducing the ICT into schools, people in developing countries can become aware of being able to reach the same standard of living as the individuals in developed countries.

The ICT can also improve the co-operation of local actors. This must be facilitated to meet their needs. There are several examples of this. Based on the local needs many programs are intended to help developing countries. Convincing results can be achieved in this way. Holistic Grassroot Mobile Climate Services [12] present a good example of this. Here the purpose is to develop a MSc level course where local Kenyan students can study holistic grassroot climate services in their circumstances. This is facilitated by the development of a smart mobile phone network, by which they can communicate with each other and thus share information.

This smart mobile phone network can help local people to alleviate and even resolve their current health problems. Among other things Kenya struggles with the HIV/AIDS problem, a high child death rate and low life expectancy. These can partly be addressed by the ICT in educational contexts. Here the ICT presents a powerful tool for people to share information in order to improve their health conditions.

One actual example is to educate people how to find clean drinking water. It is possible to build an ICT information system where communities can share

information regarding water. The ICT team work can also facilitate cohesion as people co-operate towards a greater good.

ICT can also be a way by which to *strengthen the democracy*. The information share as far as possible by means of the ICT in education can make people work together. There can be several tribes within one country and even now there is a risk of civil war in many African countries. Some of them are currently embroiled in civil conflicts. One of the reasons why these conflicts occur is because tribes do not communicate with each other.

Information must be shared equally with everybody as it does not just belong to those people living in cities. The problem is that there is often a lack of internet access in the countryside where the need is bigger for this kind of service [13].

When these countries have attained a stable democracy, they will not use their energy to fight against each other. They can really start to develop their country in a way that Western companies do not profit from the present chaotic internal situation.

The use of the ICT in education can open up many opportunities. It is a fact that in Africa, for example, the access to the internet is much lower than in developed countries [13]. This means that most people get information in a random way, as to what is happening and what is really important. In my opinion, the ICT in education can have a significant impact on the way of life and the standard of living. To share information with local people in their needs by means of Western, developed modern ICT learning management systems is the key to improve the life. This process must be done in line with the rules and guided by the circumstances in the target developing country, not in the way most suitable for the helping developed country.

2.5 Challenges

The main challenges and limitations are institutional issues, politics, educational issues, the internet access and the health and life expectancy of the people [28, 29 and 31]. Generally thinking it is difficult to promote development in any area in a

country which is teetering on the brink of civil war and where internal circumstances are unstable. A stable democratic system facilitates internal development. On the contrary an unfair political dispensation (for example threats of a civil war in Mozambique) leads to the stagnation of development. The country must be stable in order to facilitate investments in the ICT in education. International education aid organizations do not invest in politically unstable countries.

The LMS [1, 21 and 32] is more than just the facilitation of internet access, as most teachers think it is. It requires also good teaching practices in order to reach convincing learning results. Still there are no good accesses available in the rural and poor countryside, where the need is the largest. The death rate of children remains high and diseases are prevalent. Lifetime expectancy is lower than in developed countries.

The most important issues concern the lack of capacity at all levels to integrate and support the use of the ICT and the lack of necessary ICT skills among teachers (the LMS is more than just the internet).

Some positive impacts have taken place thanks to initiatives in the local educational technology [1, 21 and 32]. Education has improved, but only in the biggest cities. In the countryside, where many people live, remain still several challenges. Access to information has somehow improved but the situation is not as good as it should be. There are still many problems, which relate mainly back to the local infrastructure (including mobile network, broadband network, teachers' education level etc.) especially in the countryside. Rural people have mobile phones and there are many data services available, especially for banking [23]. The main broadband lines are only located in the main cities. However, the knowledge of available educational services is growing everywhere, thanks to the impact of the ICT mobile infrastructure.

However, the situation is not comparable to that of developed countries. Internet availability is weaker in Africa [16], so there are still many opportunities left to develop mobile data services until a saturation point is reached. However, it seems

that some mobile phone services are developed differently in Kenya and in developed countries. One good example is the M-Pesa [23]. If to compare M-Pesa development the situation in Finland, some banks have activated mobile banking applications lately there.

Somehow, it looks like a part of the resources are wasted, possibly due to corruption and heavy bureaucracy expenses of the aid organizations. As a whole, Africa is not a very stable environment and development has not proceeded as far as one would have expected after the introduction of the internet. Here all countries are not the same. However, *non-conflict* countries are much more prevalent than those with *conflicts*.

There are some key principles that need to be taken into account. At first one must grasp that everything should be dictated by the local needs. Development needs to occur at the pace and level prescribed by local rules and needs. The most important thing is to build human capacity, especially teachers and educated people. Establishing an enabling policy environment is also very important. In addition, it is very important to enlarge access to the ICT infrastructure and connectivity, especially in the countryside, outside the big cities. When all of the before mentioned has been done, it is valuable to harness digital learning resources (LMS) by all possible means [32].

International aid programs may be difficult to implement and sustain. They do not necessarily focus on the right and real purpose. Instead, their organizational structure tends to be top heavy and a remarkable amount of money is thus used for its maintenance (for example Unisex). Funds are thus wasted to feed an ever hungry "black hole" and corruption tends to flourish [2].

In developing countries, the culture is different. Their sense of time varies a lot from developed countries and things do not necessarily happen as quickly. Developing countries have their own unique way to execute tasks. In social terms the situation is also very different. Even at the beginning of a phone conversation people share

feelings before moving on to the real point. This is not so common in developed countries, where action is targeted at execution, even in phone discussion.

A way must be found to discuss the real needs of people, even in rural areas. The local people in charge do not necessarily disseminate information and they have their reasons for not doing it. It is thus very important to *foster meaningful discussions* and justified *relationships* and contact local people as this can lead to good and sensible actions being taken in the target country. Universities, situated in these areas, are in the key position to assist. It is very important to identify people with whom it is possible to have open discussions.

One possible way to help the communities in developing countries is to simply give them funds and trust that they will find the best way to spend it so that they will profit best from it as they know their local needs.

3 METHODS USED IN THE STUDY

3.1 Questions and methods

The study has three research questions, listed below:

> Question 1: W*hat are the main differences in mobile application development between developed and developing countries currently*?
>
> Traditionally universities have first made the development process. Then the results are taken for local needs.
>
> Question 2: W*hat kind of mobile application is best for students needs in the University of Elrodet*?
>
> Question 3: W*hat is the mobile application development process between the local university Elrodet in Kenya and farmers ?*
>
> How to ensure that also the needs of the farmers are taken into account while developing mobile application.

The methods of this study are employed at two different institutions. First, to study the requirements as needed by students and teachers at the University of Eldoret and how they want to use this HGMCS application. In this research, they are referred from the point of view of the ICT for education [1, 21 and 32]. From the point of view of the diffusion dynamics the situation looks similar compared with Finland. This scenery is dealt with in the analytical phase, application development process in Kenya UEO and in Finland. The inherent features of the smart mobile phones are developed accordingly, so the native applications are more suitable here.

The second scenario is the use by farmers and to ascertain what their requirements are in the communities in regard to this mobile application. In this study, they are referred to with the mobile social development point of view in mind [17 and 22]. In addition, ICT for change is the driving force behind this situation [7]. In this case this scenery is also handled in the analytical phase, application development process in communities of Kenyan farmers. In this case, mobile phones are mostly low-end models, used mainly for speaking. The native features of the phones are not so well developed, if one looks at them from the data application use point of view. In addition, a variety of phone models are in use and web and hybrid applications are more suitable here, at least at the beginning. The situation may change if end-users use more developed models.

In the first phase, this constitutes the first situation, which is the educational development of the HGMCS network for use by the University of Eldoret. This is under discussion. Typically the development process originates at the universities and then it continues to final users. However, the development process concerning wanted mobile application is complex. At first the application will be built according to UOE needs as it may not be so useful to farm communities for they generally do not use mobile phones with data applications.

3.1.1 Methodology

I have a telecommunications engineering background and I worked 12 years for a mobile operator in Finland. Therefore I have experience regarding mobile data development in Finland. I employed this background in my comparative study towards an understanding of the development in Kenya.

The methodology in the first case constitutes a mixture of both *qualitative* and *quantitative* research. A common misconception is that a study must follow either of the approaches. The best results should follow if both methodologies are used on different aspects of the data. The views of the students' and the teachers' must be evaluated by the project. They should be queried as to whether a better quality of

teaching has been established and how this has improved accomplishment of the study objectives.

This study was mostly done through conversations with people who either *live in Africa* or *who have visited* there [11, 14, 30 and Appendix 1] as well as through research *article.* The questionnaire, an important element of the study, was sent with people to Kenya. This questionnaire poses questions regarding the current status of mobile phones and mobile applications as well as future development processes, mainly in Kenya, but also in Africa as a whole.

In contrast to the qualitative approach, one should also statistically analyze the quality of teaching by this ICT solution.

The methodology in the second case is more complicated. It would be good to do some research as to which mobile phone models farmers actually use in their communities and whether they will switch to newer ones in order to facilitate the use of additional data applications. More facts about the present situation regarding mobile data development in rural communities is necessary before one can carefully proceed with this application. It looks like there is no good connection between universities and local people in rural villages in Kenya, at least not so strong as in Finland. It makes this case more difficult to carry out.

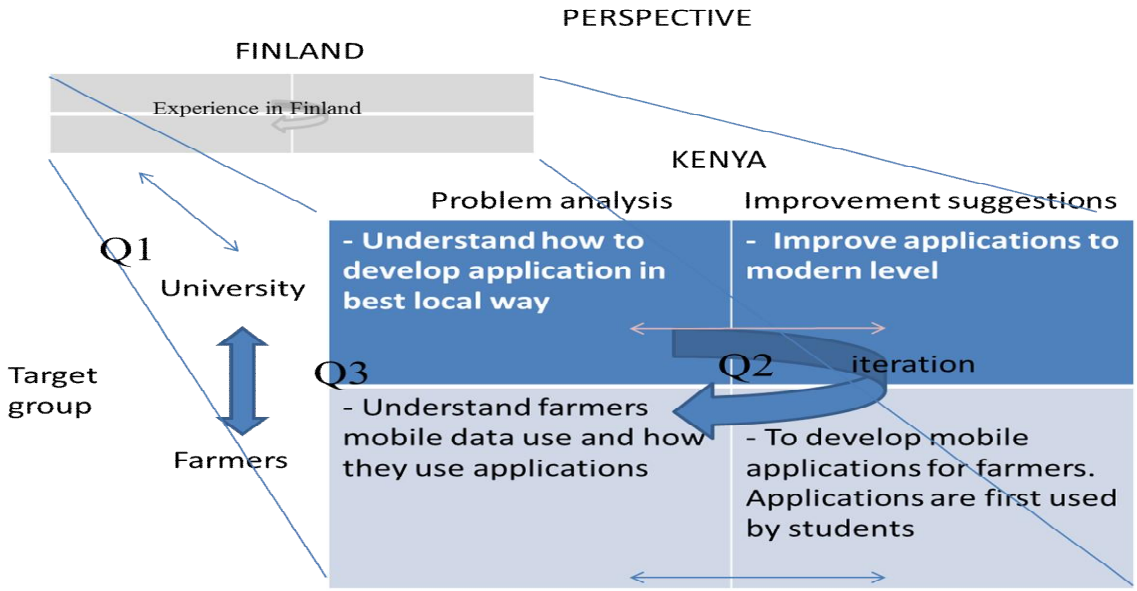

Figure 4: Research method between Finland and Kenya

3.1.2 Theoretical methodology: Basic needs of the students and farmers

Presumption: In theory, this solution will noticeably improve the satisfaction of the students and will better address their needs. They will benefit from the solution and will attain better education. This will result in increased satisfaction amongst the focus group: they will be happier, they will have less stress and they can then concentrate their energy on other important matters.

In the second phase recommendations are made for the HGMCS mobile application on the needs of the farmers. Because of the connection between the university and local people in the villages, university has got a strong position in order to take this knowledge to farmers.

In theory, when university students have got good mobile applications for learning, it will help also local farmers later in many ways. After students can use mobile applications in the best way, they can disseminate this knowledge to local farmers and communities and help them in the best way.

3.1.3 Practical methodology: Education resources

Presumption: In practice, this solution will increase employment, result in educational benefits and allocate better available resources. Also farmers in their communities can have this information in enhanced use via university resources.

3.2 Material classification

Material in this study is classified in the following three categories. They are

1. Discussions with local people in Kenya. Discussions with visitors in Kenya. Discussion with research group in Finland [11, 14, 27, 30 and Appendix 1]
2. Documents (internet articles, journal articles, newspaper articles), [see references]
3. Statistics [see references]

3.3 General: Development in developed countries

In developed countries, long prior to mobile phones, fixed phone networks were built everywhere (figure 2). Alexander Graham Bell patented the first fixed telephone in 1876 and this impacted upon the mobile phone development process in the *developed* countries differently than in the *developing* countries.

Mobile phone development in the world has not been similar everywhere, not even in the developed countries. In Europe the GSM standard was already popular at the beginning. Currently the GSM standard is the most popular 2G standard. In America, the development process has been different and it was divided digitally between TDMA and CDMA.

However, nowadays depending on the iPhone model, mobile operator, origin and contract, iPhones can be used by both the CDMA and the GSM standards. TDMA has been outdated in the USA.

Mobile phones have undergone many changes from the first models to current touch-screen application supported smart phones. Nowadays one might say that mobile phones are like computers. Applications are currently the most important feature as they are used generally and worldwide.

3.4 General: Development in developing countries

In the African countryside there has never been a fixed network. A fixed network refers to the traditional public switched telephone network where phones were connected by cable to each other. Therefore, the development processes has been different there. The mobile phone revolution [19] has been rapid and overwhelming so that people have adopted mobile phones as their primary communication tool. According to [15], mobile data traffic is growing fast globally, but especially in developing countries.

It has also led to an interesting development path. A successful example of it is the Kenyan M-PESA, a form of cash carried on a cellphone [23].

In Africa people buy mobile phones to have a work and good connections to each other. Farmers use their phones to access market information, such as tomato prices for example. The Mfarm-application is available as both a web based and Android version in Kenya [20].

Currently it looks as the African mobile technology and data development is growing fast as reported upon in the news [26]. Many applications are used to help local businesses. However, according to questionnaire results obtained from Finnish people who have visited Kenya, the use of mobile data may not rise as quickly as expected [Appendix 1].

3.5 Business models of mobile operators

Originally mobile operators charged users by CDRs, Call Detail Records. Every phone call had an identification track record which included details on who called

where, how long the call lasted and so on. Normally operators measure their business by ARPU (Average revenue Per User, also sometimes called average revenue per unit). This is a measure used primarily by consumer communications and networking companies and is defined as *the total revenue divided by the number of subscribers*.

Nowadays, especially in view of the constantly rising data levels, new business models have been developed. Providers mostly charge users periodically fixed prices or the price is calculated according to the amount of data used. In developed countries, phone calls have progressively moved towards the internet (for example Skype). This explains why the business logic of the mobile operators' is now in trouble. The situation is different in developing countries where there are no fixed networks and people use mobile phones much more frequently just for talking to each other. However, the situation is also changing in these countries. The use of data is steadily rising, although there is a delay when compared to developed countries. This exerts pressure on mobile phone development everywhere in the world and in this way mobile operators must change their charging systems in order to survive. However, SMSs still seems to be a very good income for mobile operators everywhere in the world.

3.6 HGMCS – network challenges in Kenya

From the point of view developing country, this study focuses on one example, which will hopefully enlighten the whole picture. It is the HGMCS project in Kenya, where the recommendation of the best architecture model is planned to find the best mobile application solution. The main criteria are: general sustainability of the main users, administrators and mobile operators. Usability is also important and this echoes the Finnish way of life. Possibly, in the Kenyan opinion mobile application development is not the same thing. However, it is clear that in the beginning of this project *requirement specification* and *prototyping* play a more important role in Kenya than they do in Finland. As mentioned before, in Kenya mobile phone applications development process is different. We must consider very carefully the local circumstances as they will surely have an effect on the recommended solution.

Climate service mobile application is very important to local people (for example to farmers) in Kenya and its importance will grow in the future. Climate is changing, especially in the developing countries, for example in Africa. IPCC has paid attention to this problem as well [12].

The average temperature worldwide is rising and this is causing many problems. Even now, there is a lack of water and food. In addition, health problems are common. Climate extremes also affect Africa more severely than they do in developed countries. Africa has no resources to correctly address this problem. This mobile application can be useful towards helping local farmers to understand climate changes.

Theoretical criteria are different in Kenya. Questions, which must be taken into account. One example, is the time delay (years) between developed and developing countries. Is it so that developing countries develop exactly in the same way like developed ones, only years behing. Or are there other possible development tracks available. Is it the only important difference that needs to be taken into account. The sense of time in Africa is different and the Africans do not adhere to a fast time rhythm. In the private sector, they are risk averse. In government, bureaucracy and public procurement really waste time.

This places the software development under pressure, because this project is intended to proceed, as much as possible, by means of local resources in Kenya whilst considering their circumstances.

If we assume that web applications are available among the main users of the HGMCS, it means that they have at least a 3G network with data connection. It can be checked out by modem and laptop combination. End users also have smart mobile phones, which support this solution. After that, it is possible to develop mobile Java based applications dedicated to each mobile operating system (ecosystem), if needed. It looks like 3G is available in the Baringo area, where the HGMCS network is meant to be built.

3.7 Sustainable development and problem analysis

A sustainable development point of view is different in *developing* countries from that in *developed* ones. As mentioned before, differences still exists. People in developed countries are more used to mobile applications. There are many applications available through many different mobile ecosystems.

In developing countries, especially in the countryside, people are not so used to mobile applications. They use mobile phones mainly for speaking and sending SMSs. It is possible that some of them use mobile phone applications as Facebook or mail. However, the prevalence of data use is continuously rising. Available mobile applications seem to be mainly designed for Android phones. It looks as if the use of data is not so common in Kenya yet. Data services are not cheap either [Appendix 1]. Farmers use mostly TV and radios, not mobile phones. In the countryside, where there is not a good mobile data network, it is possible to access data services through a modem and laptop combination.

This sets limitations to mobile applications development. The culture of doing things in Africa is not so time and project orientated as it is in Europe. That is why one must pay attention to the application development process.

A process of implementing mobile application development in Africa follows. First it is a good practice to ascertain whether the modem and laptop combination is possible for data services. If it is possible, then mobile–web development is a good continuation of the development process. When it is ready the application can finally be modified quite easily to fit a required ecosystem (Android, Windows, iOS etc.).

It is important to notice that in Finland requirements for building mobile applications are different. People are used to employ and develop them as well. The sense of time is quicker in Finland. It means that solutions more complicated are already possible in the first phase, for example Android based peer to peer solutions. It looks as if this is not possible at first in Kenya. Maybe after *simpler* solutions have already been tried and found to be good enough more *complicated* applications can become

possible. The basic rule is that *application development should be made in accordance with local conditions*.

3.8 HGMCS- use local cases in Kenya

At present, farmers in Kenya follow the weather forecast mostly from radio and, in some cases, from television. However, it is only a short-term forecast and it does not help them in planning long term (months ahead) farming. Indigenous knowledge on spiritual and old habits is important to be noticed, as people are so used to them even now.

The HGMCS application is planned to help local farmers to improve their farming practices. It is a holistic long time window application. Because farming is a question of life and death to them, this improvement is important in order to help farmers. A long dry or wet season may cause serious damage to farming land.

3.9 HGMCS – KMD - use data and test network

KMD-data requirements are concerned with weather and seasonal forecasts as well their consequences.

First season prognosis and action recommendations for farmers are very important. This will address the issue of how they should plan their farming order to manage the climate-related risks of the season.

At the beginning of the month, the weather of the month is important. Based on it, farmers can successfully adjust their plan.

Daily information about ground wetness and possible action recommendations are also important (e.g. need for irrigation if possible). Daily pest and plant diseases can be communicated and joint actions recommended by local experts and stakeholders. Pest observations may need real-time attention provided by smart mobile phones (voice and SMS).

Decisions on how to handle these services must be made in co-operation with local stakeholders. Something like ground wetness and drought risk information is negotiable with hydrologists.

There are *five kinds* of data types. *First*, prognosis and action recommendations; *second*, forecast audio-recording; *third* GIS-type figure material; *fourth* graphics and plots and *fifth* local observation information for example ground wetness, pests and plant diseases as well as related recommended actions.

The size of the data and its format are not yet clear. The best information is available in KMD homepages. It is presumable that the first three data types require most space and the last two less. Most likely audio-records require most of the data space and data transfer capacity. When defining the format, must also pay attention to the fact that not all users (e.g. farmers) can read.

The HGMCS network will primarily be built on smart mobile phones and secondly by laptops. Audio-records can hopefully also be transferred between mobile phones. In farming communities laptops cannot be calculated. It looks like data transmission will be challenging, especially at the beginning of this project and this requires a lot of planning and prior testing.

It looks as if it is possible to modify the KMD data so that it is usable in a HGMCS application. It even makes mobile Google drive option possible while managing the data files inside the HGMCS network, among the users. However, this question requires clarification.

4 ANALYSIS OF THE STUDY

4.1 General description of the HGMCS application

4.1.1 Network

The following figure presents the required final HGMCS application and network. It shows the situations how it looks like in the use of University of Eldoret in Baringo area. More information about the Baringo area is available in Kenya open data survey pages [18]. The other case explores how farmers in their communities use it and this requires more examination.

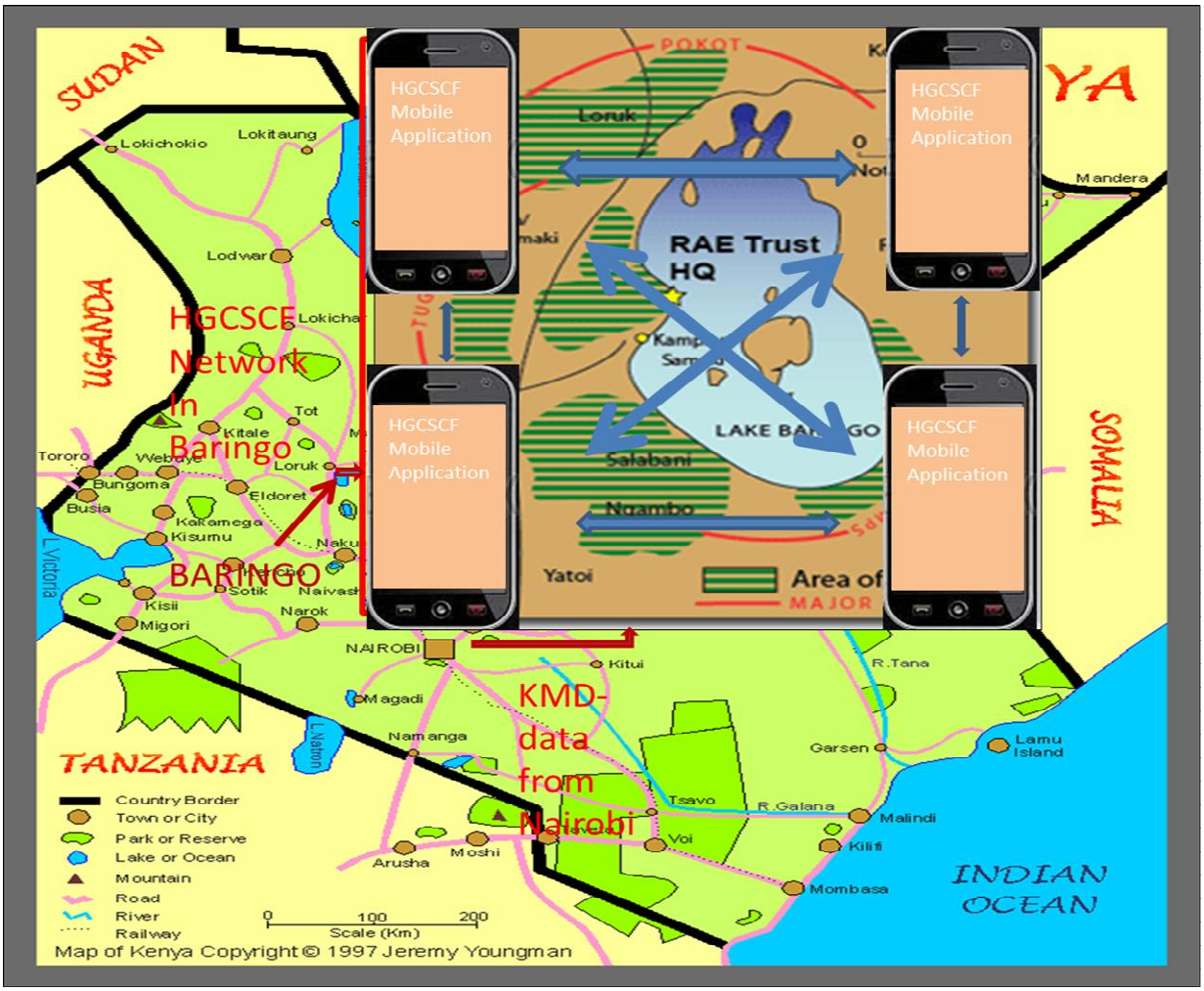

Figure 5: Required HGMCS-smart phone network in Baringo in Kenya

This study was started in May 2013 with a need to better understand *sustainable development* and *possible mobile applications* in Africa. Next, the project started in Kenya in autumn 2013. This was possible under the co-operation project between UEF and UOE regarding the development of mobile data climate services.

During autumn 2013 and winter 2014 this study was carried out, mostly from internet articles and UEF e-library data sources, to facilitate a better understanding of the present situation, especially in Kenya. Finally, in spring 2014 the first version was ready. Project requirements were quite clear from the beginning but, as mentioned before, it is not easy to obtain information from Africa. However, emails were exchanged between the UOE staff and me. Statistics were also interesting because it looked as if the use of data is really rising rapidly in Africa. One big problem during the study was that it was hard to get correct, first-hand information regarding mobile data and mobile phones in Kenya. Finally this information was available from one questionnaire feedback. Therefore this study gives the correct idea of the current situation in Kenya.

4.1.2 Smartphone network requirements in Kenya

A HGMCS smart phone network must contain inside network and 3G connection to international institutions like KMD, KFRI and the institute of hydrology. This internal network is the most important part of the solution. The prototype process phase, in co-operation with University of Eldoret and University of Eastern Finland, will ensure the specifics of the internal network. This prototype process phase is expected to find best solutions to the HGMCS mobile application for local farmers in communities. This is the encouraging challenge of the project.

4.1.3 HGMCS mobile application: possible variants

According to the study in the application there are three possible variants, which can be built [5]. They are referred in the following way. Web apps (W, 1) (mostly HTML5), Hybrid apps (H, 2) (with hybrid apps you are running a mobile web app in a native code frame) and Native applications (N, 3) (Android, platform specific SDK). In addition, web application with separated Gmail and mobile Google drive (WGG, 4) is possible and it is added here as a fourth possible choice for comparison. It is Hybrid application with separated Gmail and mobile Google drive (HGG, 5). Native application with separated Gmail and mobile Google drive (NGG, 6) is possible as well. The development process is divided into two parts: the phase 1 proto and the final phase. In phase 1, only variable data is taken into the application. In the final phase, it is also possible to exchange files between the users and to modify as well as save them.

It is possible to find the best solution to all the situations from web, hybrid and native mobile applications. There is *no absolute best choice* because each mobile application type has its own inherent weaknesses and strengths. The final solution depends on the particular needs. It is largely and mainly up to development resources and local needs. There are many high profile mobile web applications like YouTube, LinkedIn and Facebook. At the same time one has to realize that their development has cost considerable amounts of money and time. LinkedIn and Facebook mobile applications also have solutions for mutual messaging inside the application. It is also one of the requirements of this HGMCS solution, so they serve as good examples.

Facebook was originally wrapped around a web app but nowadays it is native because it was thought to be too slow since its use started. The comparison between native and web is not so simple. The use of mobile web applications might feel like native. It depends on the situation.

Several studies have already taken done on this topic, for example: A framework for technology decision making [5]. In that study framework was designed so that two main factors were taken into consideration: *device* and *need*.

Technically thinking native application was absolutely the best. In that study [5] *native application* scored the most points, namely 1400. Points refer the studys [5] pointing system. *Hybrid applications* scored 1200 points and *the web application* only scored 600 points. From these three variants, mobile web application is the simplest. Some people think that it is not even an application but just a web page mobile version. Android low-end phones are popular everywhere in developing countries so they cannot be out of question in this study. In the context of developing countries, mobile web and Android native are the best application variants, without forgetting the native option. However, native application needs more consideration. However, this is not all that must be taken into account when offering a recommendation about architecture. As was pointed out earlier, local circumstances are important and differ between Kenya and Finland. In this study they will be referred to as ***local socio-economic factors***. They are explained in the next table left.

Table 2: Comparison of socio-economic factors between Finland and Kenya

	Finland	**Kenya(farmers communities)**
Sense of time	fast	slow
Current mobile applications	lot of them with high quality	few
Need for mobile applications	high	slow, rising fast
Readiness to use mobile applications	good	not so good, developing
Readiness to update mobile applications	good	not so good, developing
Availabity of information	good	very limited
Maintenance support	good	not so good

4.2 Discussion about commercial and legal process First: Business case

As stated at the beginning, one needs first to ascertain whether the suggested solution is really wanted. Therefore a pre-study is very important. In this case, pre-study was proceeded in Kenia together with the local university in Eldoret. In addition, international aid programs may define whether the suggested solution is welcomed or not.

It is challenging to create a business case scenario for HGMCS services mobile application development in the African context. However, in the presence of the current climate variability and change as well as the situation of the farmers, it is quite easy to understand the need for these holistic climate services in general [27]. There is no way the revenue of the investments for these services because it could even be a question of survival for local farmers. In addition the developed climate services can improve their everyday living quality.

4.3 HGMCS development process recommendation

4.3.1 Prototype- phase1 (one directional data transfer in the network)

In this optional HGMCS solution the data transfer takes place only in one direction. The KMD data is modified to an application and holistic seasonal or daily weather information is available through a mobile application. The users cannot modify the data or send any emails.

4.3.1.1 Web – solution

This simplified application, without a two-directional network for the users, can be built in two optional ways. The simplest solution is the web-based. It is slow but easy to maintain and develop during the process in which results are convincing. It works in all mobile phones. It is also a good choice in the proto-phase because then it is possible to evaluate what is right/wrong and what needs to be added to the application.

4.3.1.2 Android – hybrid

There are many examples of applications, which are first designed as hybrid like in Facebook and LinkedIn. Therefore, it is reasonable first to make a web based version. As written before in this study web is needed in terms of domain needs. Hybrid application can be created from web apps by wrapping it in a thin device specific wrapper. Hybrid solutions help web applications to use specific features of the mobile phones more and make the application faster. They try to create a native

app. In many ways the hybrid option is successful but not all its features are alike in the native. However, according to the study [5] the hybrid option can get twice as many points compared with web apps [5].

Also the Facebook was originally an app wrapped around a web app. However, nowadays it is a native application as well.

4.3.1.3 Android – native

The solution can also be built as a native based solution, like Android. It means that code is made for example by C or C++ programming language. It works much faster, but only on Android phones. The Android native mobile application development process is more complicated but more suitable to these conditions. However, it is also possible to have most of mobile phones features available by java coding as well. Java coding may also be simpler.

4.3.2 Final version – phase2 (connection between HGMCS network users)

A two-way data network means that the network users can send emails to each other. In addition, the properties of the first option are available as well. The two-way data network users can also modify files and manage them easily so that every network node has access to the same available updated information.

4.3.2.1 Web solution

Transferring data files and maintaining them is possible in the domain in the same way as normal email services. As stated before, this is the easiest, albeit a slow solution.

4.3.2.2 Android - hybrid

The needed communication and file management characteristics pose a challenge to the chosen domain. In case of the two-way data network the Android-hybrid domain is needed to meet the needs. Many well-known applications like LinkedIn and

Facebook are hybrid. Lately they have been developed increasingly towards a native direction.In these apps, users can send emails to each other inside the application.

As written in the prophase, a hybrid version can be suitable in this case. It helps to get more from the specific features of the mobile phone and to make applications faster. In spite of the queries made, it is not well known what kinds of phones are used by people in communities in Kenya. Most likely they are low-end Android models. Therefore the hybrid option can be a good solution as well.

4.3.2.3 Android – native

Here the data file transfer and maintenance is integrated within one application. This is a complex and expensive solution. The most difficult question is how to manage data file transfer and data file versions. A useful option could be a web based solution development. As mentioned before, this is a slow and technically poorly developed solution. However, web solution can in the best way solve data file management problems within its own domain.

Other solutions must be taken into consideration. An Android native application is possible but there are challenges to be addressed. They are explained in next sub chapters. In this mobile application, KMD-data file transfer and data file maintenance are integrated inside.

4.3.2.3.1 Android native application solution

One idea to make the desired application is an Android native based application. It is possible to design it so that only variable data is changing in the mobile user interface. This makes the application faster. In addition it reduces the amount of data transfers in case the data value does not change. It is possible that the available 3G connection speed causes a bottleneck, especially in the rural areas of Africa. This makes it worthwhile to consider an Android native based application. Anyway,

mobile operators, especially Safaricom says that it is ready to develop its network, if needed. So finally, data speed is not the bottleneck.

Also a native based application is the best choice, if performance is wanted. Since apps work with the device's built-in features, they are easier to work with and perform faster on the device.

Communication and data management/transmission is a very important part of the application. That is why a native based application may not be the best choice here. Then no other mobile phone operating system is valid. Administration and changes are slow and not up to a standard, because every mobile phone must be updated individually. This is not a problem in a web application where administration is easy. Even with the use of a hybrid application it is not a big problem.

There are also other important reasons why an Android native based application does not work well. Smart mobile phones are like computers but there are still problems.

Data file transmission and administration between smart mobile phones is a drawback, at least in real-time by a peer-t0-peer (p2p) p2p-model. A p2p-model means that phones are vertices, equal to each other. It is not a good choice, even in a server-client system where one phone is the server and another, the client. The reason for this is that mobile operators do not allow it. They do not like servers in 3G connections. There is even an example in Finland where the mobile operator, Saunalahti, closed all its TCP-ports, except 500 and 2222, which are input ports. Then there must exist a server computer between mobile phones, where clients ask about changes. That is why there must be a server, which takes care of the messaging process. Thus, finally the Android solution does not differ much from web solutions, but it is more limited and more complicated.

Of course it is possible to build an Android native based solution with peer to peer and web server. This solution is complicated. Why would one want to create this kind of a combination if a web based solution is also possible? Actually the performance may not be the bottleneck here because mobile networks are developing fast, also in Africa.

The fact is that the final users are not so adept at using mobile data applications [Appendix 1]. It means that development and maintenance are more challenging than in Finland.

4.3.2.3.2 Android cloud solution

One possibility would be to use a cloud solution to take care of the file management. There are many important things which must be considered first. Let us think of the example of a Google drive where many users can update documents. In this case, the mobile phone works as a computer. There are cloud services available for Android mobile phones for example [25].

In this case application is only meant for one user from the point of view of managing files. If there are many users, possible problems will exist. They are for example like how can to handle many users and their rights. What can it say when the cloud allocation is full. How to handle possible errors during delete file(s) or modify setups commands. In a web based solution these kinds of problems do not exist.

If we make a cloud service for Android as read-only service, there are still problems. Mobile phones need to know the current file URL-situation. They can be fixed, but problems may still persist. Either not all services support this alternative, is it possible to create an information file where mobile phones can find the newest file URLS. This may work but the solution still has weaknesses. Hence it is not recommended.

4.3.2.4 Fourth variant – Android native with separated Gmail and mobile Google drive

Mobile Google drive and Gmail are the existing applications of the Android Operating System. In the final phase this is useful for communication inside the network and for modifying and managing files. However, this solution is not easy to use because it is not an integrated HGMCS application. It requires attention of the

end-users and care for correct use. In addition, KMD-data should be in a format that allows this data to be modified in the mobile Google drive (MGD).

4.4 Discussion about the technical solution choice process

Native applications require more work, before they are completed. This extent of functionality is rare in one single application. Despite of a platform solution the preparation costs by any software company can easily be tens or even hundreds of thousand euros. Therefore here one has carefully to check the specifications.

There are *four possible options* to proceed with the application. *The first option* is a web application with a domain server, which works in every mobile phone operating system with a browser and data connection.

The *second option* is a hybrid application, but in the front of it a web application must be built. After that it is possible to wrap it as a hybrid application. This choice is a quite acceptable recommendation in this case. Under this application and domain it is also possible to send and maintain files within the HGMCS network.

The *third option* is an Android native/Java application, which works only in Android mobile phones. There are available also other mobile phone brands, like Windows Lumia and iPhone. However generally thinking, Android is the best choice, if one has to choose an application, which is connected to only one operating system. Because Android uses open software, it is popular nowadays, especially in developing markets. It has secured a big market share, which is increasing all the time. In this case mail services and files management are integrated.

The *fourth option* is an Android native/java application with separate Gmail and mobile Google drive. In this case they are not integrated.

However, there are difficulties if one wants to build an Android native application in accordance with the final phase specifications, including connections within the network. This is difficult and expensive to build without a domain. The needed domain is available straightforwardly in web and hybrid versions.

4.5 Final comparison of the four possible solutions

There are many comparisons available for the development of possible mobile applications (web, hybrid and native). Here follows a list of properties, which are important in the comparison of the development processes in Finland and Kenya.

Comparison of the properties in the four possible solutions:

1. Usability level by different available mobile phones.
2. Interface speed.
3. Maintenance.
4. Usability of all required properties.
5. Complexity and price of the code.
6. Effective use of the mobile phone properties.
7. Problems related to a resilient use of the latest version of applications by the end-user.
8. Use of the chosen domain in the second, final version of the application.

In the foregoing are listed the questions, in order from one to eight. The answers to them can be found in the next table with the question number on the left (Comparison of the properties). Of course, the properties are important in the choice of the solution. Also the file format and size for files supposed to be transferred between HGMCS smart phone network users is relevant information. If the files are supported by a Google mobile drive so they can be read and modified under it version by version, then everything looks easier.

Table 3: Comparison of the four possible application variants

	WEB APPLICATION	**ANDROID NATIVE WITH SEPARATED GMAIL AND MOBILE GOOGLE DRIVE**	**ANDROID HYBRID**	**ANDROID - NATIVE + INTEGRATED EMAIL AND FILES VERSIONS MANAGEMENT**
1	Suitable to all mobile phones. Quite easy to update to work in all mobile phones as hybrid.	Fits only to Android - phones	Fits only to Android – phones.	Fits only to Android - phones
2	Slow, even too slow	Faster but functionality is not integrated together	Faster	fastest
3	The simplest	Simple but the use of it is not integrated in one application	More complicated	Could be easy if all specifications (email & file mgmt.) are well considered
4	Yes, all properties in one application and domain	Requires more interference by the end-users	Yes, all properties in one application and domain.	Yes if the interface is well planned
5	Simple and the cheapest	Also cheap, Gmail and mobile google drives are ready	More expensive	The most expensive
6	A weak solution	More effective, functionality not integrated	More effective	Yes. The most effective solution
7	No. Management easy to do in one domain.	Yes	Yes. Every mobile phone has a suitable version.	Yes. Every mobile phone has a suitable version. Requires attention of the end-user.
8	Good	Good	Good	Not so good

According to the required properties the wanted functionality (especially concerning the data management) fits best with a mobile web based application option. As *communication* is a central part of the application it definitely works better in this way.

As mentioned before, the p2p- and the server-client models do not work well in the native alternative. Therefore a recommendable option seems to be the web based solution. It means an own, dedicated domain/server (for example www.hgmcs.ke) in Kenya, where all data are stored and all end users/mobile phones can communicate easily and exchange information. This server offers the newest information. Data management and administration will then be easier. A web based solution does not exclude the Android option which can be modified later to work as an Android java based application as well. However, as mentioned before, it would be better to start with a web based application for practical reasons. The sense of time, work culture, software technology and project management model in Africa differs profoundly from that of Finland. Also, this project is supposed to be *located in Kenya* as much as possible. This means that the local circumstances must be considered very carefully. At present, the rate of development in Africa is growing but this does not always solve local problems in software development.

A web based solution requires more data speed to work well but it might finally not be the problem here. The 3G network should be fast enough and mobile operators can improve their network when needed and if possible. In addition location-based services are available in web solutions as well. Also, it seems that people accept better laptop connection web services, so this might be a more natural option. There are currently services, which support this choice. The situation will possibly change in the future when people use mobile services more.

If the web version is ready first, then hybrid applications can be built quite easily for all mobile phones, even with low-end data feature models in Kenya.

In addition with the web being the most common platform, it is easier to find people to produce web based than Android based applications. In a web platform solution the technology would be php, html, html5 etc.

One possible problem is that it is difficult to find a ready solution on which to build and continue development, except for some libraries with common functions for example map view and so on. It means that the main development must be started from its very beginning and as mentioned before, this may mean a significant amount of work.

4.6 Recommended solution process – proto phase

Figure 6 explains the general structure of the telecommunication network in developing countries. Generally, in the rural areas mobile services are available only via a mobile switching centre. The mobile switching centre is then connected to a fixed network via a PSTN centre. More details on the abbreviations are readable in figure 7.

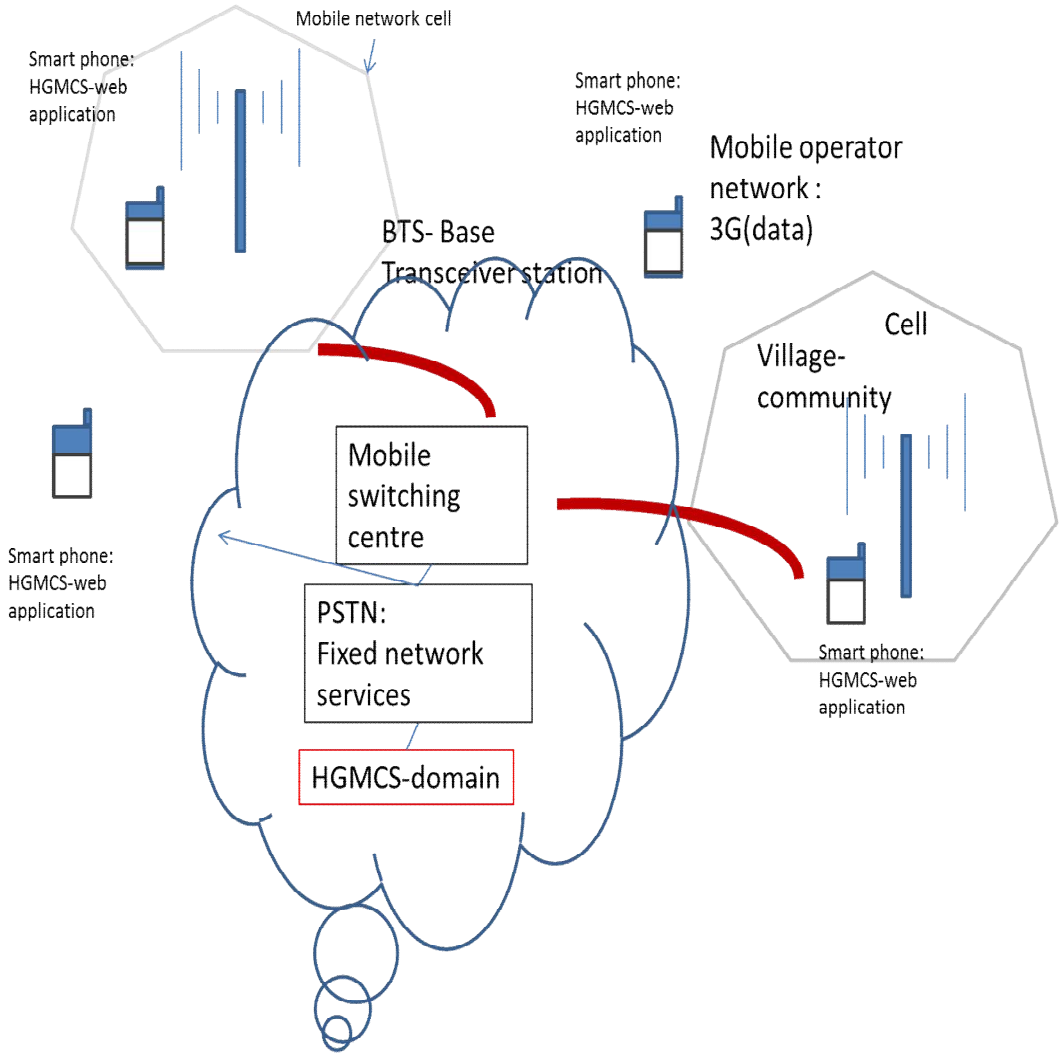

Figure 6: HGMCS- prototype network in developing countries

The final recommendation at the beginning is a web based solution in the proto-phase. People are used to employ web based solutions like laptops with modem connection in the countryside. Therefore, the change to using web-based mobile applications is not so significant. It seems as if users are not yet comfortable with the use of native based applications. The speed and the applications are not the problem but the cost of the connection is [Appendix 1]. Therefore, native applications look feasible because there only variable data is transferred to the mobile phone and the data amount is smaller. Almost every mobile phone has a data traffic option.

Compared with the Android solution there are inherently more good things in trying to solve the problem in this way. The reasons for this were explained in the foregoing. Even the performance of a web application in a mobile phone is not essential because data is not handled all the time, but at most a few times a day. One also presumes that network speed is increasing all the time for the KMD data transmission. The main reasons being the ease of administration (especially regarding the data management), the African perception of time and their activity in this project, availability of the users (not OS tied). It would be recommended that the system domain be eventually placed in South Africa, not in Kenya.

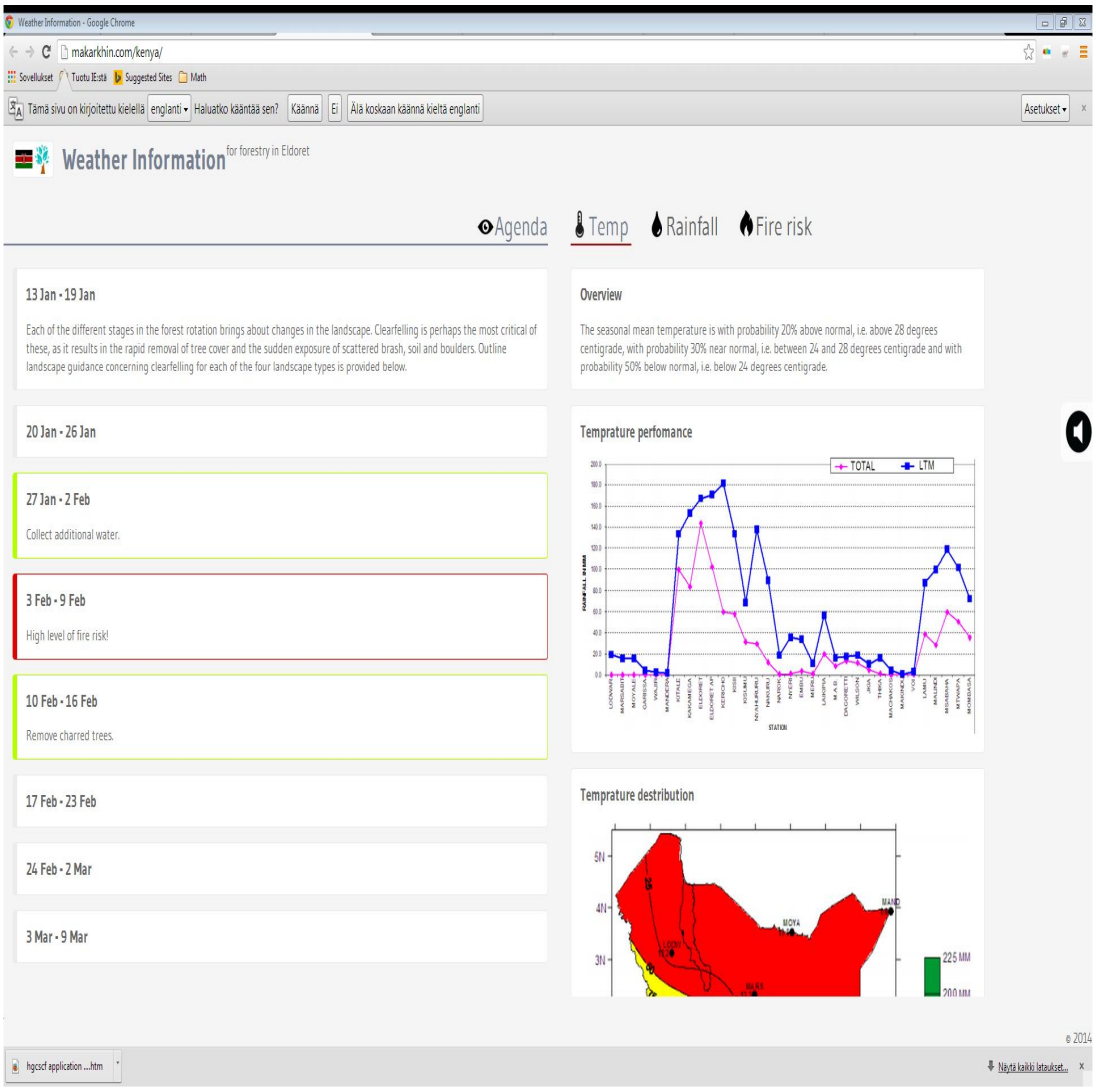

Figure 7: HGMCS - web application prototype

Native applications are also possible but in order to understand local circumstances (like requirements and specifications concerning the development process and local socio-economic factors) it is important to start from the basic phase (web solution). Development resources are easier to procure when one is building web solutions as they are cheaper. When requirements are clear and end-users are happy with them, it is much easier to start to build native solutions like Android. In addition, it looks like the available smart phones in Kenya are mixed so a web-solution is suitable for them all. The biggest problem with this it is that it is a slow process and users may possibly not be so satisfied with it.

When requirements are clear and the web-solution is working as required, it is recommendable to build (at least) a hybrid application. Then it is possible to use more innovative smart phone features to make apps faster etc.

A native application is possible as well, but there are items to be solved concerning the communication within the network like the need for a domain. How to send files and manage KMD files is still then a case to be solve. In web and hybrid applications, this is not a problem as the domain is already existing and available.

4.7 Recommended solution process – final phase

In the final phase, when requirements are clear and web-solution and hybrid applications are working as wanted, it is recommended to finally build a native application in Kenya. The requirements of the end-users will specify whether to build a complete native/java based integrated version, where email and file management are integrated into the application. It might be difficult and expensive to build the application, but the features of smart phones are best available to make apps as efficient and fast as possible. Hybrid application or hybrid/native with designated Gmail and mobile Google drives form also a possibility. Alternatively, hybrid application with separated Gmail and Google drives could be developed, which would be cheaper and not so complex. However, this approach will no longer be a

HGMCS network. Communication and data management are handled in an open network.

In Figure 8 the development of HGMCS mobile application is explained at University of Eldoret. Finland and Universities in Kenya are generally speaking at the same level of the development. In the first phase the application is hybrid (on the left) but finally also native based. The biggest difference between the farmers is that native based applications are possible for all most common mobile phones. It can be found out from the figure 9.

The situation is different in the countryside of Kenya. It is explained in the figure 9. There low-end mobile phones are mostly in use for talking. Smart phones are not so common. That is why there are challenges to develop mobile applications for final users, e.g. farmers. The proto-phase application is web-based just to understand the requirements (on the left). The final solution is also a native Android based application (on the right). Mobile Google drive (MGD) refers to the mobile cloud service, where data is uploaded. However, need to pay much more attention whether native applications are possible for farmers. As explained, the development process starts from simple web-version and when possibilities to use more complicated applications develop, then evolution to hybrid and native applications are possible.

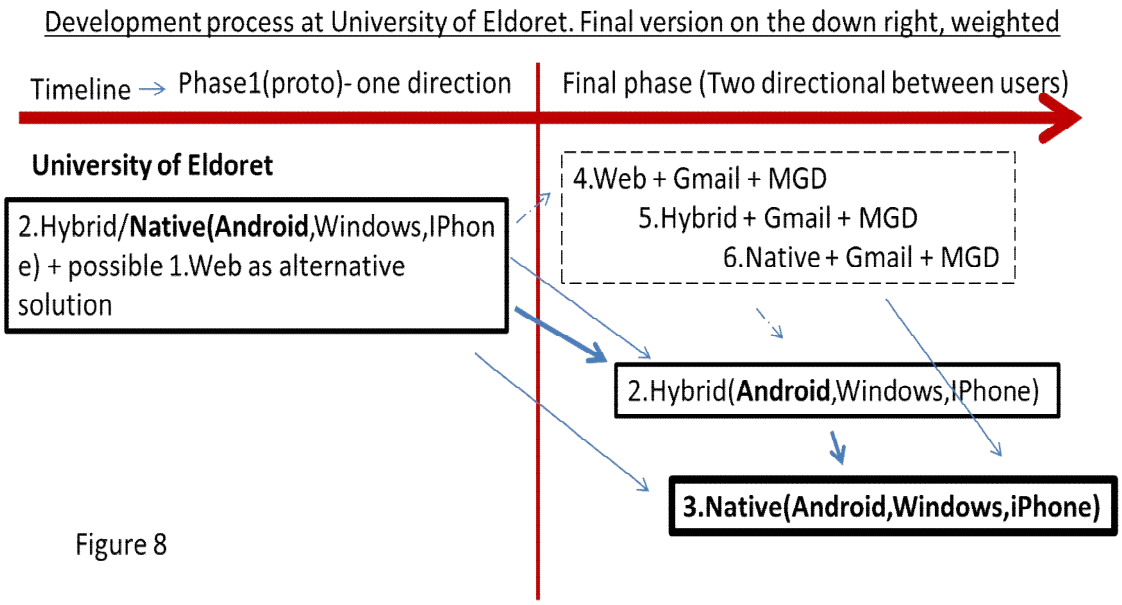

Figure 8: HGMCS application development process at University of Eldoret

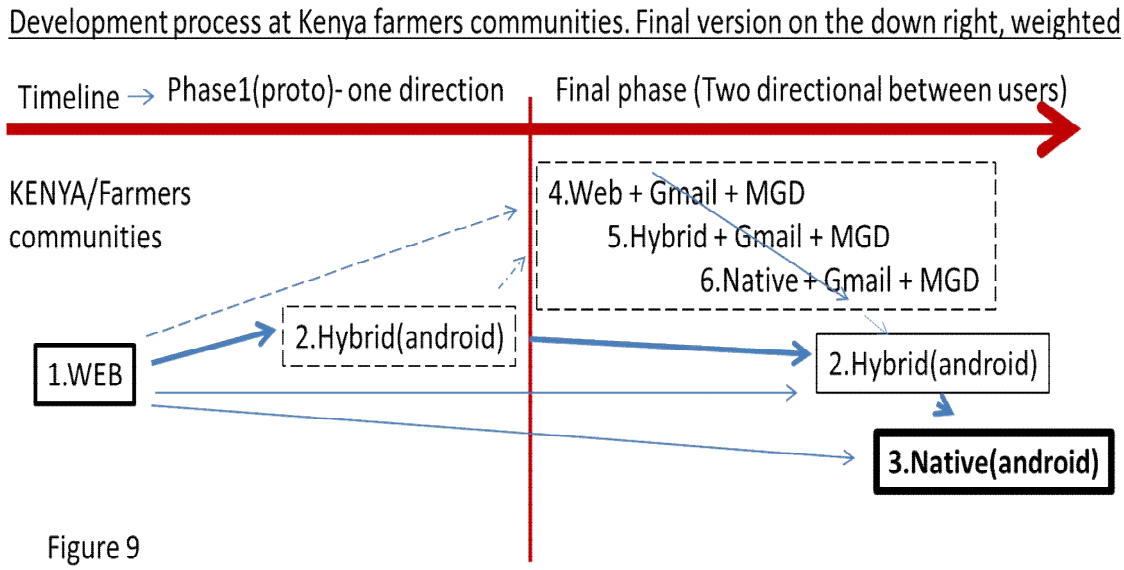

Figure 9: HGMCS application development process at Kenya farmers

4.8 Sustainable development impact

According to the results of the questionnaire [Appendix 1], the cost of data is problematic. People have mobile phones with a data traffic option but there are not so many local application developers. It strengthens the opinion that application development in Kenya should be started more from the base level like indicated in Figure 8. Then the results can be better when the current situation is clearly perceived. It is not a good idea to just build a native application suitable for Finland and transplant it as such to Kenya.

One must also pay attention to the fact that the development of mobile data applications in universities differs from that in the countryside. The University of Eldoret may build a very sophisticated HGMCS application, even native in nature, and use it successfully in their tests. However, it is not possible to take this application as such to local farmers. The farmers will probably experience difficulties in using the application because they are not use to it. It also looks as if Android phones have got a strong foothold in Kenya. It means that most applications are used there are Android applications.

The role of the university in developing things first is clear but in this case the difference between university and local farmers might be too pronounced. Therefore a genuinely participatory approach with the local farmers from the very beginning is recommended.

4.9 Difference analysis between Finland and Kenya

4.9.1 General differences and facts

In Finland people are more proficient in the use of mobile applications than in Kenya. These socio-economic factors are stable, well known and highly developed. Mobile applications are more widely used in Finland than in Kenya. This is due to socio-economic factors, which were explained in the foregoing.

Therefore, in Finland there is no special need to build a web application first. The solution can be directly hybrid done. Local telecommunications network architecture can also help to build a two directional communication HGMCS network. A public switched telephone network and wireless network solutions are available almost everywhere. It means that hybrid based solutions can be deployed by transferring files between HGMCS users. The situation is different in Kenya because in the rural areas there are mostly only mobile networks available. It is also important to notice that the final phase application development faces the domain problem if a native application is insisted on with mailing and data management inside the network.

4.9.2 Finland and the University of Eldoret

There is not such a big mobile application development difference between the situation in Finland and that of the University of Eldoret (UOE). In the comparison (as explained in Figure 8) they are the same. UOE has the resources to design any mobile application which they may want. It is even recommendable that they create a highly developed application, like hybrid and native, instead of web based solutions. Then it is easier for them to take this knowledge to citizens in Kenya.

4.9.3 University of Eldoret and Kenya farmers communities

There is a big mobile application development difference between the University of Eldoret and Kenyan farmer communities. Farmers do not have resources and knowledge on how to use mobile applications. According to statistics, only about 10 percent of people use mobile data in Kenya. Mobile data is also expensive. Also one problem seems to be that universities are not so good in developing mobile applications in Kenya. They may have resources but lack of knowledge is a potential risk. In addition a holistic participatory paradigm between the University of Eldoret and the local farmers is still a challenge for both parties.

5 DISCUSSION

No articles dedicated to this topic during the last three years were found. There were only general comparisons about native versus web applications. However, this information does not cover all the information needed to understand the question in its entity. The number of mobile applications as well as the technology to build them is, however, developing rapidly and makes the choice of this topic actual. The HTML5-coding system develops fast as well. There are many ways to build mobile applications. It is more sensible to affect the development process in Kenya from the basic level just so that one can understand the local context of the developing country well. However, this is only the Finnish point of view. It is not so easy to offer insight as to what is the best way in Kenya. Some people in Kenya may disagree with this opinion as it has been put forth by a person who has never visited the country.

5.1 Mobile applications development

One of the problematic issues in worldwide mobile technology development is the difference between *developed* and *developing* countries. Research has already been done regarding this topic [22]. However, it is not always clear how the local situation (in for example Africa) is, especially if there is no local information available about the circumstances. Mobile technology develops fast and that is why it would be technically desirable to see that ideas are similar everywhere. However, there are differences, which stem mostly from local circumstances like needs of the local people, income level and perception regarding time and life rhythm. One interesting remaining issue is the maturity of the local people as regards the acceptance of new technology, for example the use of mobile data services instead mobile speech.

It is possible to find the best solution to the needs of the mobile user from web, hybrid and native mobile applications. It is not easy to say what the best choice is. Every situation needs to be considered as a *unique one* and then the different possibilities need to be carefully contemplated as each of the possibilities have their own inherent strengths and weaknesses.

This thesis aims to present the main differences between Finland and Kenya by using mobile data services development as a vehicle to the study. The first case is that of a *developed* country, Finland. The second case is that of a *developing* country, Kenya in Africa. Data services are used more commonly in Finland than in Kenya. However, already fifteen years ago mobile operators in Finland were optimistic that mobile data services would be the future business instead of speech. It took almost ten years before the situation became as predicted. It is interesting to compare this situation to the present one in Kenya where people are using mobile phones primarily for voice communications. Mobile data services are not used as much, especially not in rural areas. Technologically, mobile networks are developed enough for data internet services.

For ten years ago the situation was not clear at all in Finland. It was a common belief that mobile data would be the future. It was the future but not so fast than expected. At the moment the same issue is not yet clear at all in developing countries. There are interlocking requirements, which need to be taken into account.

Differences do exist. The development of mobile applications must somehow be made simpler. The needs of final users, their knowledge, software maintenance (latest version problem), lifestyle and unique culture are more important to notice in Kenya than in Finland.

Some opinions and results/outcomes are strong in this study and some people may disagree with them. Based on the background of the author, it is safe to assume that the results are predominantly correct. However, opinions can be changed if they are found to be incorrect. The use of mobile data is rapidly increasing, especially in developing countries. It is very possible that it is increasing there at a quicker pace than in, for example, Finland, because there are no alternative choices. It is even possible that they are developing somehow in a different way. Therefore it is not so easy to foresee the future development of the mobile data in developing countries. It would be too easy to say that the process is similar to that of developed countries.

It looks like the hiding of the knowledge is in use in Africa. The Africans do not want to share the information regarding mobile data development. It is justified to ask what advantage they get from that. Businesses and companies in Africa should share more information in order to procure better transactions between other parties in developed countries. The information about mistakes in this area have been made earlier elsewhere. The Africans need not necessarily make the same mistakes again. Thus it is possible for them to achieve better results in their business. In that way they can avoid possible mistakes while developing their mobile data services. Or is it so that they prefer to hide information in order to get more financial aid for Africa.

Also one interesting idea is the role of the universities in Kenya. It looks like their role as a developer is not so strong than in Finland. At least it is different because they are not connected so well to the people in Kenya. According to Figure 4, it looks like the four parts presented in this figure are losing even more and more touch with each other. This is not a good thing, if one thinks about the potential of development resources, co-operation of universities and the people, which should really work in a deeply participatory way.

5.2 Limitations

During this study, information about circumstances and the technology used in Kenya was difficult to obtain. During the study year, questionnaires were sent to Kenya three times with visitors but only one answer [Appendix 1] was received. Local mobile operators did not tell exactly what kind of mobile applications and mobile phones ordinary people really use in the countryside. Because of that, conclusions are based mostly on general available data and also from local people [14 and 30] and visitors [Appendix 1]. This information is of course an important business secret. It is also possible though that in this way local businesses in Kenya are somehow losing knowledge and essential information about mobile data development processes made earlier in developed countries.

Results are not totally correct but in general they give an accurate view about the situation in Kenya. One big issue seems to be this information hiding made by local

companies. Somebody may even question the identity and motives of the author as he has never even been in Kenya. However, according to my background in the mobile Telecom sector, I hold by my opinions and the Questionnaire [Appendix 1] verifies further my findings.

Maybe it is even an advantage, that I have never visited Kenya. Therefore I can give neutral comments about the case studied here.

The connection in Kenya between local universities and local ordinary people is interesting. It looks like it is not as strong as in Finland. It may contribute to some differences in the results.

6 CONCLUSIONS AND FUTURE RESEARCH

The purpose of this Master thesis was *to compare the mobile phone application diffusion dynamics between developed and developing countries*. From that context it tried to address the problem: what is the best sustainable way to build a smart mobile phone network application to meet the needs of the Forestry Department of the Eldoret University? It was assumed that this was a normal software development project for which the local circumstances in Kenya are not so meaningful. It looks as if the culture in Africa, which guides the development of technological services is different. The biggest reason is the sense of time - people do not yet live as time-orientated as they do in developed countries. They are not so close to mobile online service applications, like for example in Finland, where online information is easily available via mobile technology. People in Finland are also so used to using mobile applications, that it is easy to develop them here.

This thesis closes by suggesting that when one is developing data services *in Kenya*, like those in common use in Finland, the process should in fact be different. People in Kenya are not as used to mobile applications. In Finland, people are used to them to the extent that it is quite easy to develop any kind of mobile applications for different platforms. Even native application is possible to start with.

In Kenya it is recommendable first to use the simpler solutions, like web based or hybrid to avoid possible problems during the development process. Then it is possible to continue application development to native option, if this is really wanted. Most of the native features are also available by Java programming language using the Android Software Development Kit. Nowadays this is the most popular choice by application developers in that case.

One must also pay attention to who the final user is. Are they university students or farmers? Of course, finally the solution must be chosen by viewing the merits and dimension of the unique case. In this way one would presumably assure that the application will really survive during its planned lifecycle.

On the other hand a web solution looks better especially at the beginning but finally light, Android-based native applications are good as well. Web application is good because its development does not require that much knowledge and even internet pages are usable.

However, this study showed that local conditions in the target country are essential in order to find the best solution. In Finland the required HGMCS mobile application would probably have been designed in a different way. Mobile services develop fast and it means that this question is timely right now, especially in developing countries.

The situation is in flux and so it is safe to presume that the need for these kinds of mobile applications is rapidly increasing. Not everybody has a PC laptop but availability of cheap smart mobile phones is increasing everywhere.

It looks like it would be best to build Android native applications in Kenya for local farmers in the final phase. These applications should be designed so that they are simple to use and can also facilitate small amounts of variable data transfer via mobile network. There are several reasons for this: data are expensive, not so good local application development knowledge and Android phones are widely in use.

At the university, there are more choices to build a HGMCS-application, thanks to a wider smart mobile phone set. One interesting issue is the connection between local universities and farmers in Kenya. It looks like it is not that good currently and that the development is even going to a wrong direction. Instead of finding joint interests, the parties are losing more and more touch with each other.

The result of this study was interesting and raises more questions. It looks as if the availability of fixed networks is also related to how mobile services can really be developed in developing countries. In addition, it is important to be aware of circumstances in Africa (for instance their perception to time). This means that this kind of a project is best built piece by piece and at a slow pace. The point of view concerning sustainable development is also complex and requires more studies from both the technical and the commercial aspect.

Presumptions are confirmed as a result of this study. It is sure that local universities and farmers can achieve better results in their business when they choose right away to build mobile applications for their needs. If the application is good, students can learn better to use and develop it. Finally they can take this knowledge to local people and farmers as well. It is also possible that farmers should finally have a different lighter version of the HGMCS application because of the cost of data and usability. Farmers may not even have the same smart phones in use as the universities, even though there exists the data traffic option. It is also a question of the architecture on the local conditions and it may even have a substantial economical effect, how the application development process is planned.

In the future it would be interesting to launch a multidisciplinary study (commercial, social, technical, computer science) about mobile data development in developing countries (needs of the ordinary people, mobile operators business etc.). Local social-economic factors form an essential part of this subject (Table 2). Mobile data development is also connected to fixed/broadband network development.

The 3G technology is available almost everywhere. Mobile operators and people also know what has been happening in the area of mobile internet data development (including applications) in Europe and Africa. Why do people not use this knowledge? What is really the business strategy of the mobile operator to develop these services? In Europe, for example, the strategy for the past ten years has been strongly *data based* instead of based on *voice services*. However, this strategy was really profitable only couple of years ago in Europe.

It would be interesting to study, what possible effects these kind of mobile applications have on the everyday life of ordinary people in Africa. How can it improve their quality of life? What are the profits of all parties? What can still be developed? Is there any sensible way in which to study how to build mobile application in a developing country context? The developing aid point of view is important but the real need should originate from the local people. How can this be ascertained is a very good question.

No focused studies in this topic were found: mobile application diffusion dynamics worldwide. There are many points of views, which need to be investigated further. They include, for example, the interest of mobile operators in developing their data services, the interest of end users to use the mobile data services (e.g. applications), the interest of the mobile application developers to develop mobile applications in the local level country by country and so on.

For future studies it would interesting to make a distinction regarding this subject, for example, based on figure 9. It would be possible to use telecom peoples experience to help to understand and to compare differences iteratively between the situations in Finland and Kenya.

It would also be interesting to build a method and classification system according to which the use of mobile data services and applications can be foreseen globally, country by country. In that time window their use will most likely increase so much that holistic development of mobile data services infrastructure would be profitable to all participants (mobile operators, end-users as well as application developers). In the next picture are introduced possible PHD(Doctor of Philosophy) questions.

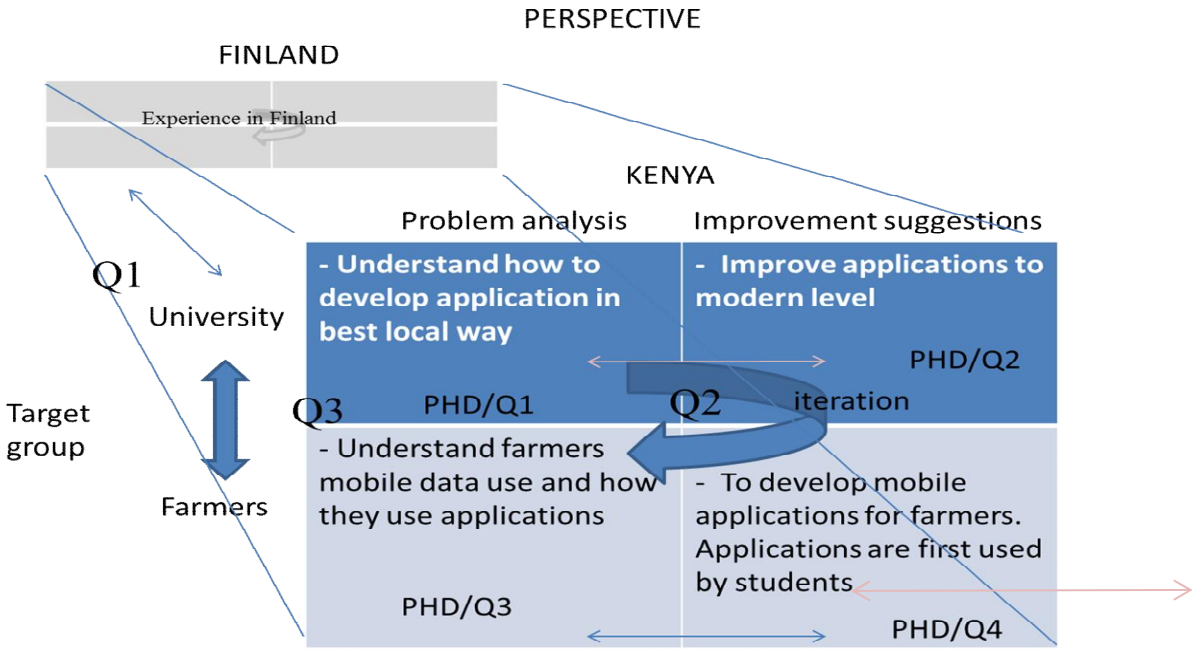

Figure 10: The proposal of the dissertation thesis

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Appendix 1: Questionnaire and results from Finnish visitors in Kenya

Questionnaire to Kenya mobile operators and regulators etc.

University of Eastern Finland/School of Computing

Respondents: Santtu Åkerman, Tapani Toivanen

Topic: Smart mobile data traffic development in Kenya, smart mobile applications development in Kenya, smart mobile phones development in Kenya, tablets, phaplets

Master thesis research about mobile technology development in Kenya

Background:

It is a fact here in Finland what happened with Sonera Germany 3g(umts)-licence in year2000-2001. It was common belief, especially here in Finland, that mobile data is the future. Lot of money were lost because people were not ready to use mobile data services then in Germany. However, nowadays situation is different. Mobile data services are greatly in use, and their data amount is rising all the time.

I've understood that 3g-network is available almost everywhere in Kenya. It is also presumable that people there know about the used mobile applications here in Europe. Anyway, according to statistics and facts I've been given, people do not use mobile internet data services (smart phones, tablets). They use their mobile phones mostly for speaking to each other.

The situation in Kenya seems interesting and I have some questions.

1. I've seen statistics (Cisco 2013) that mobile data traffic (smart phones, tablets etc.) is rising fast especially in countries like Kenya. Is it really so , what do you think ?

> The issue is mainly on providers' side: Mobile data traffic consumed by local people is almost in every case provided by pre-paid telephone subscriber connection and there is a data cap in those subscriber connections. The 3Gnetwork was present. 200 MB data cap was 250

KSH (about 2 €), which is a high price for local people. Yet the operator named Safaricom provides an application store for Android devices. So the country is really enthusiastic about the mobile. The speed and the applications aren't the problem but the cost of the connection. After the user has reached the data cap, the Internet connection is shut down. Not slowed down like in Finland for example.

2. Mobile penetration in Kenya is quite low yet. What do you think- is it rising fast in the future ?

Considering previous issues, I think that until not majority of people can afford data connections (not even speaking about the smartphones; tablets are very rare), it is not rising very fast.

3. What kind of phones (models) people use generally in Kenya ? Are they changing their phones to mobile phones with data traffic option (internet) ?

Most people have Android phones made by Techo. The hardware is not so advanced. Minority has Lumias with Windows Phone. It is very rare to see iPhones. Almost every smartphone has a data traffic option.

4. Do mobile operators have currently any business strategy concerning mobile data internet development ? If, could you tell me little about it ?

The issue in the business plan is (like said), that they cannot provide data traffic to everyone and I am not speaking about the "slums" only. People with smart phones have in almost every case a internet connection.

5. What kind of mobile applications are available to end users currently ? Are they web based or for example made to Android-phones ?

Both, but the developing in Kenya is still in the child's shoes. Those who are able to develop applications are very little minority.

6. Globally thinking, amount of mobile applications (web based, Windows,Android,iOS) are rising all the time. Is the amount of mobile applications rising also in Kenya ?

> Yes, but the Kenya still needs a lot more capable developers. Current state of programmers graduating from the universities is very low. And the enthusiast programming is very rare because of the economic state of country: the information is hard to get.

7. What kind of applications people use there (web –based which are suitable to all mobile phones or some applications especially designed for special phone model (Android, Windows, iOS))?

> Regular people use applications downloaded from the Google Play for example. The hardware of the phones is not so advanced so newest games for example are the bottleneck. Also only few phones actually support the latest versions of mobile operating systems.

8. I am especially interested about Android phones and Applications ? I assume, that Android phones are generally used in Kenya. Could you tell, compared to other mobile phones, what is the percentage of Android phones currently ? Is is rising all the time ? If not, what kind of phones people use, are they Chinece pirate phones or what ?

> Chinese pirate phones are rare. The few, which exist, are owned by students. Android phones are by far the most popular, second comes Windows phones (Lumia and Huawei). Apple products are incredible rare. I only saw one owned by a local person (high price, considered a high-end product, not affordable). Something like one out of ten is a Windows Phone. The rests are Android phones.